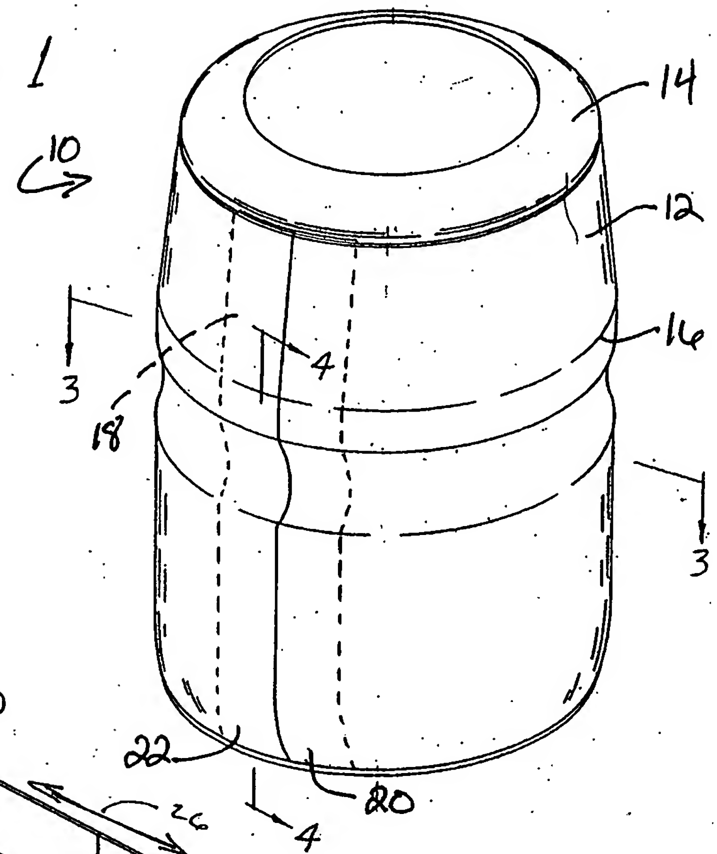
FIG. 1



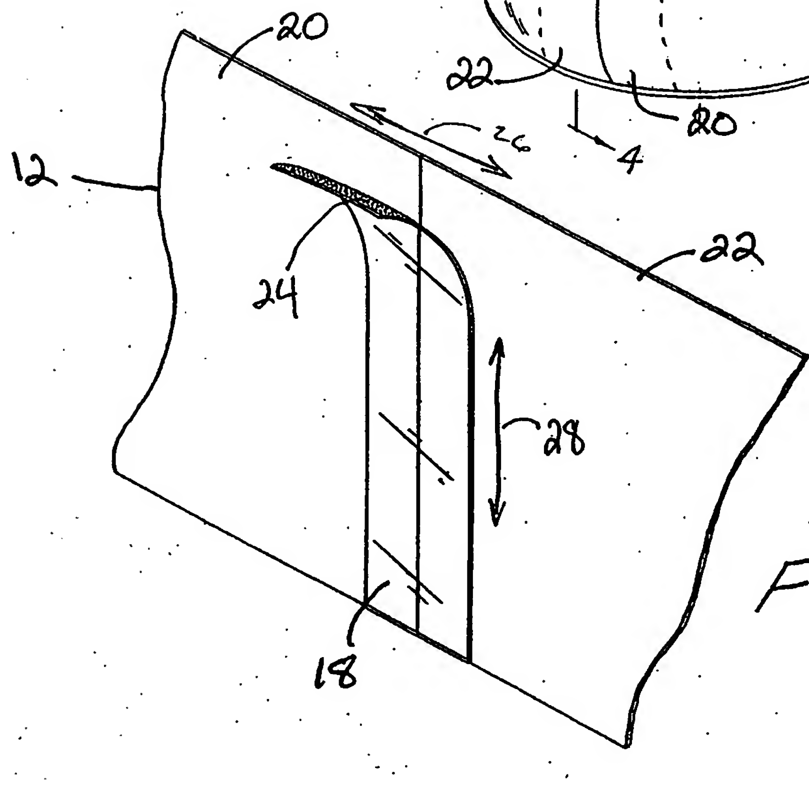
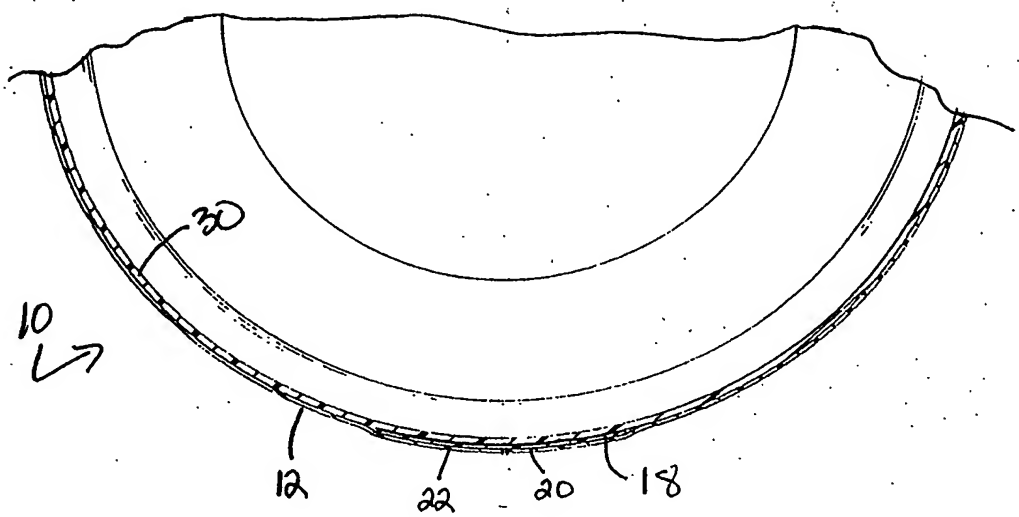


FIG. 2

FIG. 3



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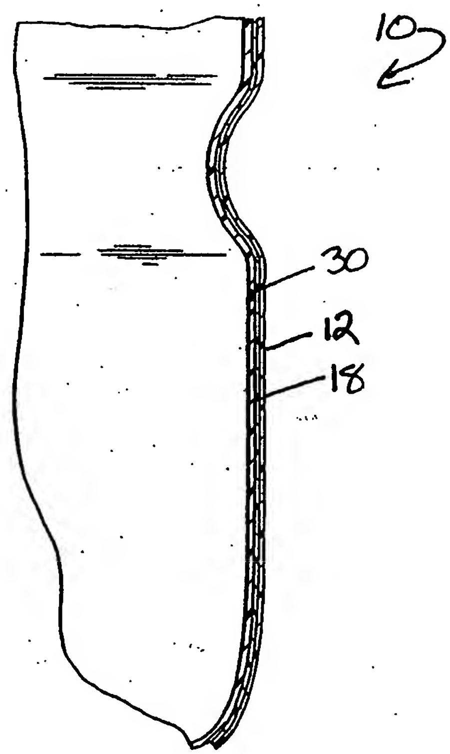
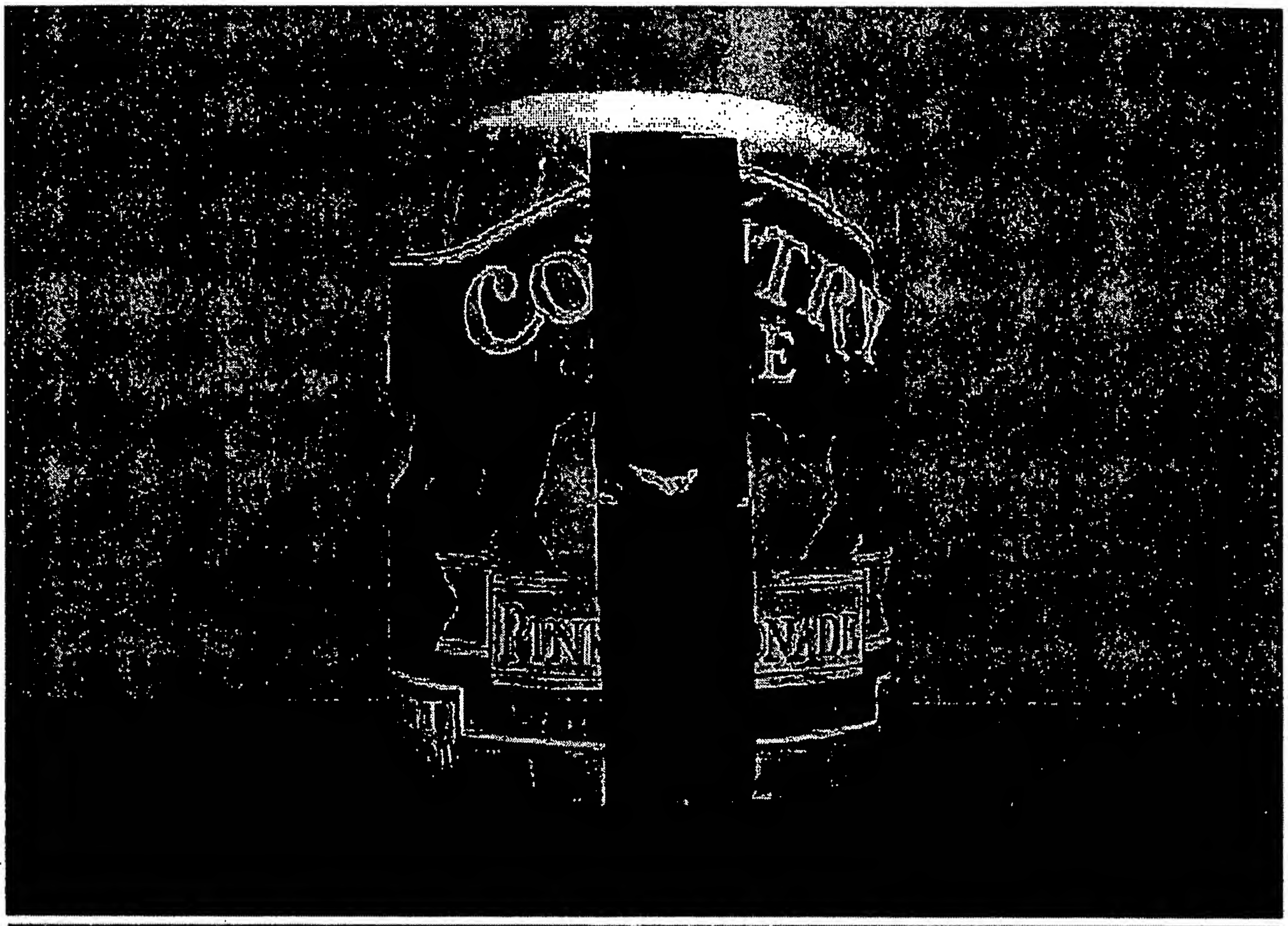




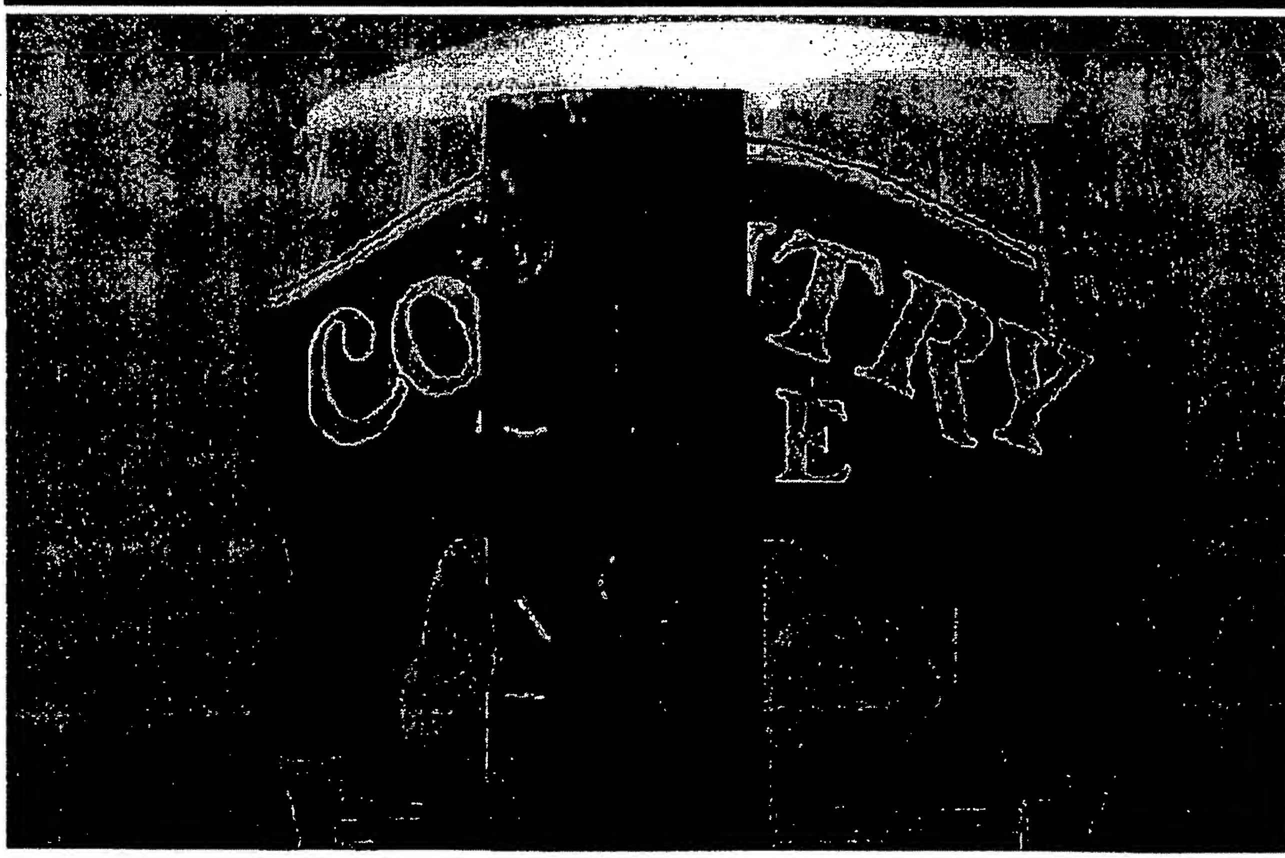
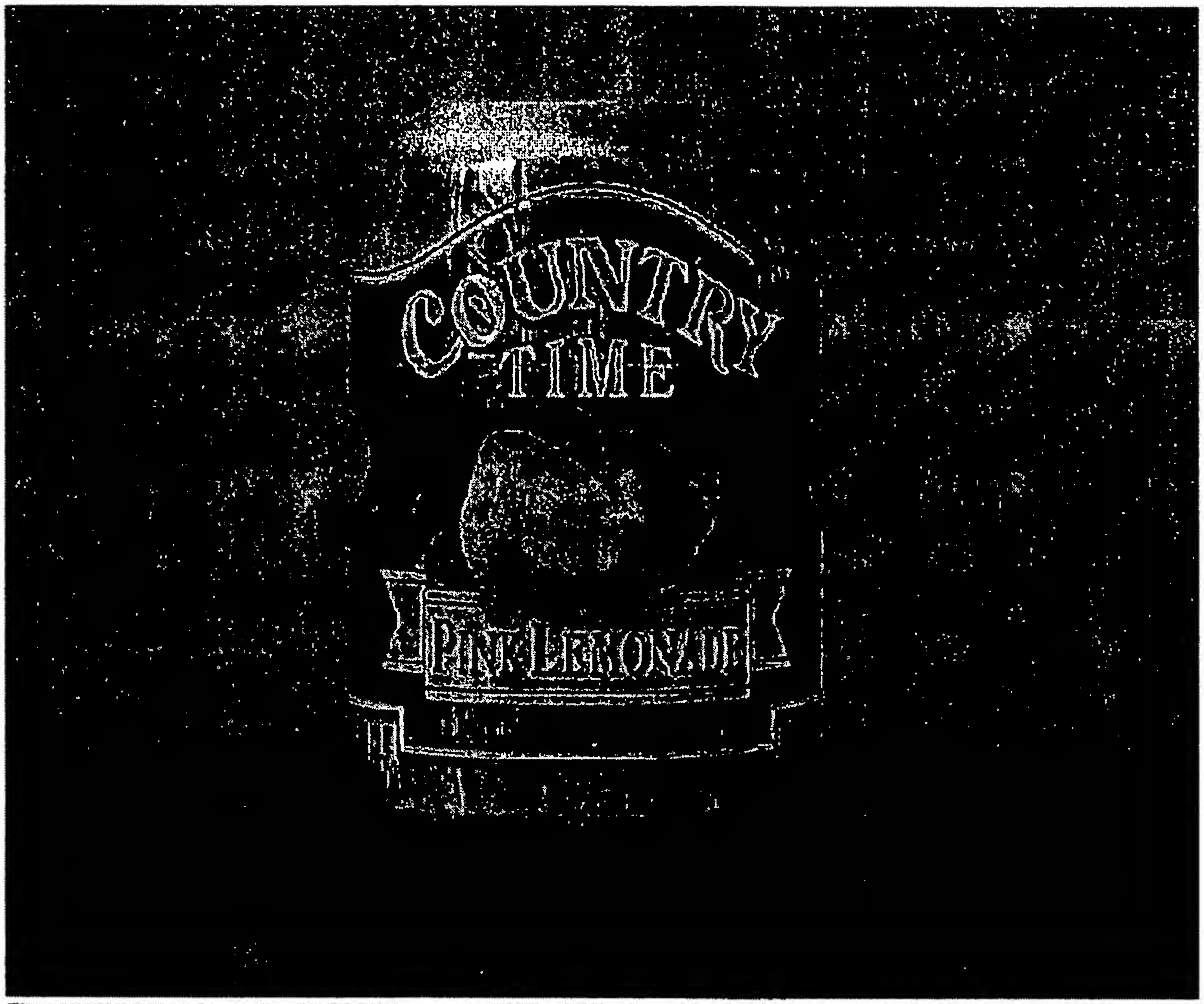


Exhibit A

Ex A



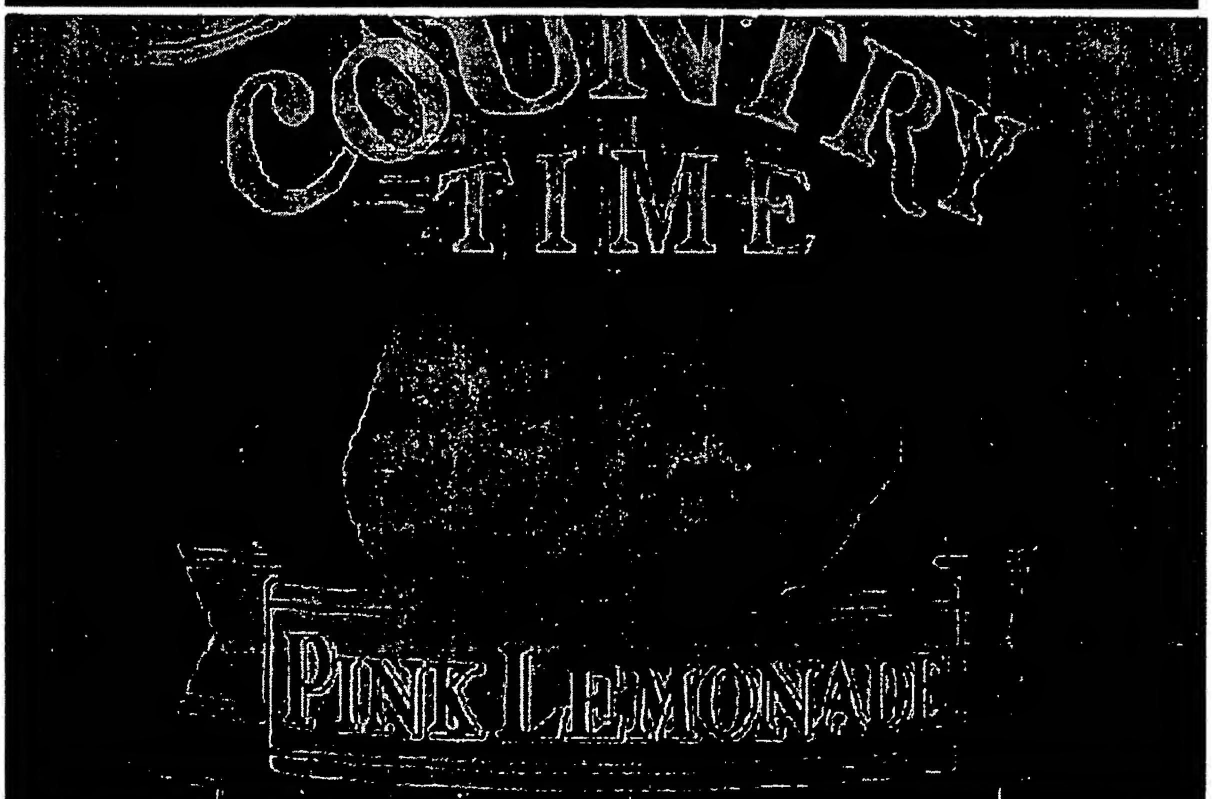


Exhibit B

Ex. B

— THIRD EDITION —

WHITTINGTON'S DICTIONARY OF PLASTICS

Edited by James F. Carley, Ph.D., PE

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means of radio-frequency waves. When heating is performed with ultrasonic vibrations, the process is called *ultrasonic sealing*. See also WELDING.

Heat-Seal Strength With heat-sealed flexible films, the force required to pull apart a heat-sealed joint divided by the joined area tested. The strength of a heat seal is sometimes expressed as a percentage of the film's tear strength or tensile strength.

Heat Sensitivity The tendency of a plastic to undergo changes in properties, color, or even to degrade at elevated temperatures. Severity of change is always a matter of both temperature and time. ASTM D 794 describes the procedures to be used in determining the permanent effects on plastics of elevated-temperature exposure.

Heat-Shrinkable Film A film that is stretched and oriented while it is being cooled so that later, when used in packaging, it will, upon being rewarmed, shrink tightly around the package contents. Blown film made from plasticized PVC is the largest-volume shrink film. Heat-shrinkable tubing of several polymers is widely used in the electronics industry to protect bundles of wiring. ASTM D 2671 (section 10.01) describes a method for testing such tubing.

Heat Sink A device for the absorption or transfer of heat away from a critical part or assembly.

Heat Stability The resistance to change in color or other properties as a result of heat encountered by a plastic compound or article either during processing or in service. Such resistance may be enhanced by the incorporation of a stabilizer.

Heat Transfer The movement of energy as heat from a hotter body to a cooler body. The three basic mechanisms of heat transfer are radiation, conduction, and convection. Radiation heating occurs when heat passes from the emitting body to the receiving body through a medium, such as air, that is not warmed. Conduction heating is the flow of heat from a hot region to a cooler one in either single homogeneous substances or two substances in close contact with each other. Convection is the transfer of heat by flow of a fluid, either a gas or a liquid, and either by natural currents caused by differences in density or by forced movement caused by a fan, pump, or stirrer. All three modes of transfer are important in plastics processing.

Heat-Transfer Medium See THERMAL FLUID.

Heavy Spar See BARIUM SULFATE.

Hecto- (h) The SI prefix meaning × 100.

Helical Screw Feeder See CRAMMER-FEEDER, SCREW CONVEYOR.

Plastics Films

Third edition

J. H. Briston, B.Sc., C.Chem., F.R.S.C., F.P.R.I., F.Inst.Pkg.

With two chapters by

Dr L. L. Katan, B.Sc., Ph.D., F.I.Chem.E., D.I.C., A.R.C.S., C.Eng., F.P.R.I.

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in association with
The Plastics and Rubber Institute

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Con

future growth range from 8% to 15% per annum. The benefits include the extension of shelf-life and this, in turn, allows for more efficient distribution, less product wastage and an attractive premium image. One of the growth areas at present is the packaging of salads. An important factor here is the provision of an anti-mist (anti-fogging) coating on the inside surface of the lidding film in order to maintain product visibility. Films used range from single films such as polypropylene to five layer coextruded films which include EVOH as a high barrier material. An interesting range of laminates is one in which the inner polyethylene ply is patterned so as to create channels from which the gas can escape. Other laminates used include some based on PET.

16.6 SHRINK WRAPPING

The technique of shrink wrapping goes back to 1930 when the ability of dampened plain cellulose film to shrink to a tight wrap on drying was utilised to provide decorative wrappings and to act as a pilferproof seal. The technique is still widely used today, especially for the wrapping of bottled drinks.

Later, in 1936, natural latex was used in France as a shrink wrap to pack perishable foods. The film was stretched and then allowed to shrink back on to the goods to be packaged. This technique has been extended using elastic plastics films such as low density polyethylene, EVA and thin plasticised PVC. The process is referred to as stretch wrapping to distinguish it from processes based on the use of heat shrinkable films. The latter technique is the one normally referred to as shrink wrapping and is dealt with in sections 16.6 to 16.10. Stretch wrapping is discussed in section 16.11.

Shrink wrapping began around 1948 with the wrapping of poultry for deep freeze storage. The film used was polyvinylidene chloride. A film bag was slipped over the bird, a light vacuum was drawn and the mouth of the bag sealed, usually with a wire tie. The bag and contents were then immersed in a hot water bath when the bag shrank tightly on to the contents. Apart from giving an extremely neat pack, shrink wrapping had the advantage that freezer burn (caused by intense dehydration of the surface of poultry) was prevented by the impermeable film, coupled with the close contour wrap. The latter also eliminated pockets in which ice crystals could form and obscure the contents.

The principle on which shrink wrapping is based is sometimes

referred to as 'plastic memory'. In other words a film which has been stretched during manufacture (at a temperature above its softening point) and then cooled to 'freeze-in' the consequent orientation of the molecules, will tend to return to its unstretched dimensions when re-heated. The techniques of producing oriented films have already been described in Chapter 8. With most films other than polyvinylidene chloride, the temperature at which a suitable degree of shrinkage is obtained is above the boiling point of water so that hot-air tunnels have had to be developed for their use.

16.6.1 SCOPE OF PROCESS

The scope of shrink wrapping has expanded well beyond the original idea of contour wrapping frozen poultry although the shrink wrapping of items of food is still an important outlet. Because awkward shapes make little or no difference to the feasibility of shrink wrapping, the technique is particularly useful for the packaging of a premium offer with the product to which it is temporarily related. The equipment necessary for such a job is capable of handling subsequent offers within a fairly wide range of size and shape.

Figure 16.4. Shrink-wrapped bottles

Shrink wrapping is also advantageous in rounding off the contours of awkwardly shaped or complex sets of items so that they do not become dust traps when on display. However, one of the most rapidly developing fields open to shrink wrapping is the production of transit packs of cans, cartons or bottles, as an alternative to fibreboard cases. Cartons, of course, can be built up into a neat

stack which is easily shrink wrapped, but cans and bottles are normally first collated on one or two fibreboard or plastics trays, before shrink wrapping (*Figure 16.4*).

16.6.2 TYPES OF SHRINK WRAP

There are two main types of shrink wrapping, namely, the sleeve wrap and the all-round or perimeter-sealed wrap. In the sleeve wrap, a tube of film, greater in length than the product to be packaged, is made by sealing longitudinally (see *Figure 16.5*). When this is passed through the shrink tunnel, the extremities of the sleeve shrink around the ends of the product (*Figure 16.6*). Less film is used than in a complete over-wrap, and the holes at each end can be used for opening the pack. Sleeve wraps are particularly suitable

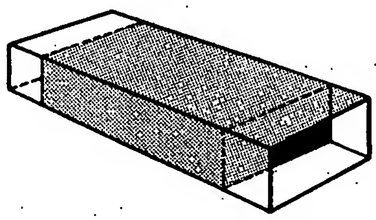

Figure 16.5

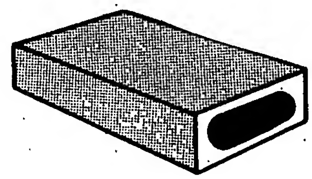

Figure 16.6

for securing premium offers or for making carry-home packs of, say, three or six unit packages, but they are also used for transit packs or one or two dozen cans or bottles. Another use for the holes at either end is as hand-holes for carrying. The all-round, or completely sealed, pack is a more efficient barrier against dust or moisture pick-up but it may be necessary to make a few micro-perforations in the film to allow the escape of entrapped air during the shrinking process.

With cans, a sleeve wrap may be preferable to a complete over-wrap because the cans could still hold residual moisture from the cooling water used after processing. In a complete wrap, condensation will eventually occur but with a sleeve wrap, the resultant ventilation should prevent this, provided that storage conditions are reasonably dry.

A sleeve wrap for holding, say, a premium offer and the product will require the use of film with a high degree of shrinkage in one direction only. For transit packs, where either a sleeve wrap or a

perimeter wrap may be used, the type of film necessary will be dictated more by the proportions of the pack.

When a sleeve transit wrap is used, the shrinkage may be unbalanced to a small degree, but not to the extent indicated above for collating two fairly small items. Where the height of a pack is out of proportion to its length and breadth, the difference between machine direction shrinkage and transverse direction shrinkage should be at a minimum. For products requiring an all-round seal, the shrinkage should again be more or less balanced.

16.7 SHRINK WRAPPING EQUIPMENT

The equipment necessary for shrink wrapping transit packs of cans or bottles will usually consist of collating equipment, tray erector, tray loader, film wrapper and sealer, and a shrink tunnel, together with the necessary conveyors.

16.7.1 TRAY ERECTION

Plastic trays do not require erection because they are thermoformed in one piece. For fibreboard trays, either manual or mechanical erection may be used. However, for high speed lines manual erection can be expensive in terms of man-power, and mechanical erection will normally be used.

16.7.2 FILM WRAPPING AND SEALING

A range of equipment is available, from hand operated to fully automatic. Basically, however, there are two main types. One is used specifically for all-round sealing and utilises centre-folded film (i.e. film folded in half, in the machine direction) and an 'L'-shaped hot wire sealer. The object to be wrapped is placed within the folded film and the 'L' sealer brought down in front of it. This seals transversely in front of the pack (and also cuts the film), at the same time sealing the side of the pack (opposite to the fold). The pack then moves forward, another object is placed in the folded film and the operation is repeated. This seals the trailing edge of the first pack and the leading edge of the following one. Each subsequent operation of the 'L' sealer, seals the trailing edge of one pack, and the leading edge and side of the following one.

For sleeve packs the usual method is to use two reels of flat film,

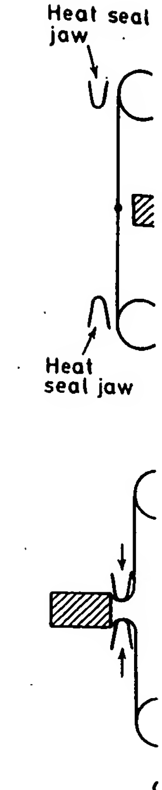

Figure 16.7. Sequence of

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16.7.3 SHRINK TUNNE

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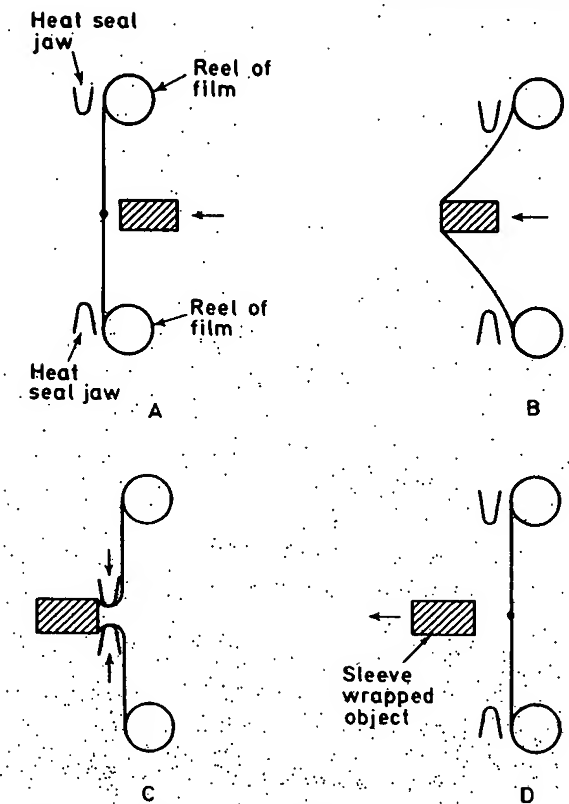

Figure 16.7. Sequence of operations for sleeve wrap

located above and below the sealing table. The ends of these two reels are first sealed together and the object to be wrapped is pushed through the curtain of film so formed, beyond the heat-sealing and cutting jaws. These are then operated to seal the pack, cut it from the web of film and re-form the curtain (*Figure 16.7*). If a complete overwrap is required, side seals can be added further along the line.

16.7.3 SHRINK TUNNELS

Shrink temperatures are often not far from the melting point of the film. Temperature control is an important factor, therefore. The normal means of heating a shrink tunnel is by hot air, and heat losses are minimised by fitting PTFE or asbestos curtains at each end of the tunnel.

16.8 PROPERTIES OF HEAT-SHRINKABLE FILMS

In general, the orientation of a thermoplastics film improves its impact and tensile strengths, its clarity and its flexibility. Gas and moisture vapour permeabilities are also reduced in some cases. On the debit side, elongation is reduced and the heat-sealing range is narrowed.

16.8.1 SHRINK TEMPERATURE

The range of temperature over which a film will shrink is important commercially. Films with low shrink temperatures require simpler equipment and also pose fewer problems with the packaging of heat-sensitive goods. In addition, a film with a wide softening range is preferable to one with a fairly sharp melting point because the latter renders temperature control of the oven more critical.

16.8.2 DEGREE OF SHRINKAGE

The maximum amount of shrink available in commercially obtainable films varies from around 20% to around 75%. The percentage shrink of a particular film also increases with the temperature of shrinkage. Films with a steep shrink/temperature curve are more difficult to handle because of the closer temperature control necessary. Polypropylene, for example, has a steep shrink/temperature curve and a temperature variation of 10°C (i.e. $\pm 5°$ tolerance in the tunnel) could cause the degree of shrink to vary by up to 20%.

The degree of shrinkage necessary depends on the particular application. For tightening-up a loosely wrapped package only a very little shrinkage is necessary, whereas the contour wrapping of a complex-shaped article requires a high degree of shrinkage.

For printed films, the problem is not so much the total degree of shrinkage as the amount in different directions. Balanced orientation obviously gives the least distortion under normal conditions but there may be complications if the product is of irregular shape. In such cases the only course of action may be to choose a simple print design which is relatively unaffected by distortion.

16.8.3 SHRINK TENSION

This is the stress exerted by the film when it is restrained from

shrinking at elevated temperatures. A certain amount of shrink tension is necessary in order to give a tight package but care must be taken when wrapping articles which could be crushed or distorted. High shrink tensions are really necessary only when the film is intended to become a structural part of the packing.

16.9 PALLET OVERWRAPPING

Shrink tunnels have been built which are large enough to accommodate complete pallet loads, and this has opened up a wide range of applications for shrink wrapping. The concept of shrink wrapping complete pallet loads was first developed for the packaging and transit of refractories. These are fragile and are often oddly shaped, thus making them extremely difficult to transport by normal methods. Using 150–200 μm thick, low density polyethylene film, a tough contour wrap can be obtained which is firmly anchored to the pallet. Other advantages of a shrink film overwrap for such pallet loads include protection against dirt and weather conditions, elimination of strapping damage, easy detection of pilferage, and a reduction in abrasion and crushing due to movement during transit.

The concept has since been expanded to include pallet loads of container glassware, bricks, and a wide range of products packed in sacks or fibreboard cases. Speeds of up to 300 packs per hour have been claimed. The shrink tunnels are usually heated by gas but electric ovens have also been used. Other heating developments include the use of a vertically reciprocating bank of heaters, and portable hot air heaters (rather similar to giant hair dryers).

16.10 GENERAL ADVANTAGES AND PROBLEMS

Many of the advantages of shrink wrapping have already been mentioned but a general summary may be useful. For the packaging of awkwardly shaped foodstuffs like hams, poultry, and so on, shrink wrapping provides a convenient and economical method for preventing freezer burn (in deep freeze storage) and for equipping the foodstuff with a second skin which protects it from contamination by dirt and bacteria. For transit packs of cans, bottles or cartons, shrink wrapping can often be cheaper than a conventional fibreboard case, as well as providing an attractive display pack. Two advantages of particular relevance to the retailer are the reduction in packaging material to be disposed of at the end of the day, and the fact that

a shrink wrap takes up progressively less space on the warehouse shelf as the contents are removed, whereas a fibreboard case takes up the same amount of space whether full or empty.

However, there are still a number of problems which can arise under certain conditions. Some are a matter of user education but others are more technical. The latter can quite often be solved technically but not necessarily economically. With the packaging of cartons, for example, care must be taken where these are coated externally with wax or low density polyethylene. Bonding sometimes occurs between the shrink film and the carton coating, particularly if there are local hot spots in the tunnel. The trouble can usually be eased by reducing the dwell time in the tunnel and by tightening up the heat control.

Inconsistent results can sometimes be traced to temperature variations within the tunnel. This may not necessarily be due to the temperature control but may be caused by running the packs through with too little space between them. Sometimes, too, different temperature settings are necessary for the same film if it is to be used for different products. Cartons and cans, for example, will need different temperature settings because of their different heat conductivities.

One of the problems of transit shrink wraps is that of mixed loads, where shrink wrapped goods are carried in the same vehicle as, say, wooden boxes or metal containers. This problem can only really be solved by separate stacking.

The question of excessive shrink tension has already been mentioned. This can lead not only to crushing and distortion of flimsy cartons but may lead to trouble with items such as polyethylene bottles. If these are filled with a detergent, stress cracking may occur if the bottles are under stress. Even if the shrink tension of the film is not excessive, stress may be induced in the bottles when they are stacked. Where such bottles are carried in a fibreboard water case, the case itself usually takes part of the weight involved in stacking.

16.11 STRETCH WRAPPING

The principle of stretch wrapping, as mentioned earlier, is that the film is stretched around the article to be wrapped and is then heat sealed. The residual tension in the film gives a tight contour wrap (the simplest analogy is that of an elastic band).

The main films used in stretch wrapping are low density polyethylene, PVC and EVA, the choice depending on factors such

Plastic Films For Packaging

Technology, Applications and Process Economics

By Calvin J. Benning

Exhibit E

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Chapter 2

Oriented Packaging Films

HISTORICAL DEVELOPMENT

Biaxial orientation is a process whereby a plastic film or sheet is stretched in such a way as to orient the polymeric chains of the plastic parallel to the plane of the film. Biaxially oriented films possess exceptional clarity, superior tensile properties, improved flexibility and toughness, improved barrier properties, and the unique property of engineering shrinkability. Biaxially oriented Saran® (PVC-PVDC copolymer), PVC, rubber hydrochloride, radiation crosslinked PE mixtures of LDPE and HDPE, polystyrene, and polypropylene are the mainstays of the industry. In the food industry these are widely used where their specific shrink properties and barrier properties are particularly valuable, or, in the case of OPP, as a base film for laminar structures.

Virtually any thermoplastic material can be oriented. The first biaxial orientation process (called Luvitherm® by I. G. Farben, for plasticized PVC) was developed in Germany in 1935. During World War II oriented polystyrene film was made in Europe for capacitors and

coaxial cable insulation. In 1936 natural latex was used in France to shrink wrap perishable foods. The film was stretched and allowed to shrink back on the goods to be packaged. This technique is still used with films like LLDPE blends, EVA, plasticized PVC, and LDPE/VAC copolymers. The process has been referred to as stretch wrapping, to distinguish it from heat shrinkable film packaging.

In 1948 Dow Chemical developed the Saran® resins and Dewey & Almy (now the Cryovac Division of W. R. Grace) developed the film process and introduced Saran® shrink film to the marketplace. This development opened the eyes of the marketplace profession to a new era in packaging.

Shrink wrapping in this sense began with the wrapping of poultry for deep freeze storage and has been dominated by Cryovac technology for many years. A film bag was slipped over the bird, a light vacuum was drawn and the mouth of the bag clipped shut. The bag and contents were then immersed in a hot water bath where the bag shrank tightly around the contents. Apart from giving an extremely neat package, shrink wrapping had the advantage of eliminating freezer burn (dehydration). (This technique is now used in many other food packaging applications.)

The major breakthrough in oriented high performance films came after Cryovac developed the Saran® bags for packaging frozen fowl. In the mid-fifties E. I. Dupont started development of high and low density polyethylene blends, and Cryovac was in the midst of commercialization of their radiation crosslinked polyethylene film. By middle 1960 Cryovac had developed a complete line of shrink films consisting of crosslinked PE, OPP, oriented polystyrene (OPS), and polyester laminates for the fresh and prepared food industries. Minnesota Mining & Manufacturing Company and Reynolds Aluminum Company have also been very active in the area of structured packaging films based on coated laminates for boil-in-bag applications. Reynolon® and Pliofilm® were very active stretch films. Since mid-1960, three polymers have emerged as the giants in the shrink or stretch film markets. These are PE (and its copolymers), PVC and PP. The phenomenal growth of OPP, to replace cellophane and to serve as a laminating base for barrier and special applications, indicates the main criteria for use – "cost and functionality."

THEORY OF STRESS-INDUCED ORIENTATION

Molecular orientation during stretching takes place in the following

manner: Below their glass-transition temperatures (T_g), polymer chains are rigid. At the glass-transition temperature they become more flexible and are able to unfold as stress is applied. If a mass of randomly coiled and entangled chains is above T_g when stress is applied, as in biaxially stretching, the polymer chains disentangle, unfold and straighten, and also slip past their nearest neighbor.

There are three rheological components to this process: First, E_1, the instantaneous elastic deformation caused by bond deformation or bond stretching, which is completely recoverable when the stress is released (Hookian behavior). Second, E_2, the molecular alignment deformation caused by uncoiling which results in a more linear molecular arrangement parallel to the surface and which is frozen into the structure when the material is cooled (Elastic behavior). And third, E_3, the unrecoverable viscous flow caused by molecules sliding past one another. The elastic component, E_2, is the major component of the stretching process.

When the film is rapidly stretched at a temperature slightly above T_g, E_1 deforms instantaneously followed by E_2 deformation (Table 1). If at some time t_1, E_2 is large, relative to E_3 and the material is rapidly quenched, the alignment deformation E_2 is frozen into the structure. If the identical stretch and quench sequence is carried out at a significantly higher temperature, E_2, the desired alignment component of the deformation, will be a smaller proportion of the total deformation; this is mainly because viscous flow, E_3, increases as the temperature is increased, so that E_3, deforms more in time t_1, allowing E_2 to relax more during the time consumed by the stretching operation. Stretching is thus a dynamic process in which orientation and return to random coil (relaxation) occur simultaneously.

Table 1. Rheological Components of Orientation

E_1	Instantaneous elastic deformation caused by *Bond Stretching* – recovers when stress is removed.
E_2	Molecular alignment caused by uncoiling which is frozen into structure when cooled below T_g.
E_3	Nonrecoverable viscous flow caused by molecules slipping over each other.

On the basis of the above theory, some general rules for orienting polymers by stretching can be set forth.

1. The lowest temperature above T_g will give the greatest orientation (and greatest shrink strength, etc.) at a given percent and rate of stretch. E_3, viscous flow, is held to a minimum by keeping the temperature as low as possible.
2. The highest rate of stretching will give the greatest orientation at a given temperature and percent stretch. Since E_3 is a slower process than E_2, E_2 will predominate during rapid stretching.
3. The highest percent stretch will give the greatest orientation at a given temperature and rate of stretching.
4. The greatest quench rate will preserve the most orientation under any stretching condition.

These principles are illustrated in Figure 12.

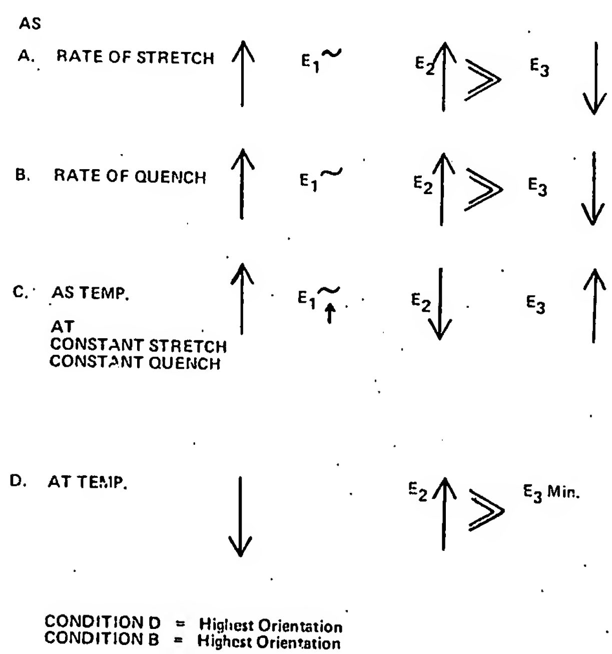


Figure 12.

Chapter 3

Orientation Techniques

GENERAL APPROACHES

The polymer sheet or tubing to be stretched or oriented can be made by the usual techniques, such as extrusion, calendering, or solvent casting. Extrusion is the most common method and either annular dies or slot dies may be employed depending on the raw material and the method of orientation. The economics of supply, cost of capital and manufacturing, etc., usually determine if calendering is the preferred method (i.e. of producing PVC film). The third approach, casting from a polymer solution, is becoming very unattractive due to the high cost of solvent, the high cost of capital, and a long list of environmental concerns. (Reynolds Company has a tetrahydrofuran solvent process for cast PVC.) Both calendering and solvent casting produce film with excellent thickness control compared to extruded sheet. However, as noted previously the economic and environmental problems have increased the operating costs of this process to such an extent that it is becoming unrealistic to operate.

Classical procedures of orienting polymers has been discussed in several British journals and books.*

---

*See Appendix 13.1.2

The orientation procedure for crystalline polymers has the following sequence:

(1.) Heat the polymer to above the melting point to destroy crystallinity (e.g. melt extrude).

(2.) Quench to minimize crystallinity and preserve the amorphous condition. (This will facilitate subsequent orientation.)

(3.) Reheat and orient by stretching at a temperature somewhat above the second order transition temperature but below the crystalline melting point.

(4.) Anneal (if desired) to reduce thermal shrinkage or rapidly quench to "freeze in" shrink energy. For this step the film is constrained from shrinkage during heat treatment.

For polymers of relatively low crystallinity, e.g. polyester, the procedure could consist of the following sequence:

(1.) Heat the polymer to a temperature well above the second order transition temperature so that the polymer is well into the viscoelastic region. This can be done with an extruder.

(2.) Cool the polymer to the proper temperature wherein the resin is elastic and orient by stretching at the prescribed temperature and rate. (Note: Here also one notes a decrease in strength at higher orientation temperatures, as in the case of polystyrene in Figure 13.

(3.) Anneal (if desired) to reduce thermal shrinkage. Again, the annealing conditions may be carefully controlled to prevent relaxation, and loss of shrink energy.

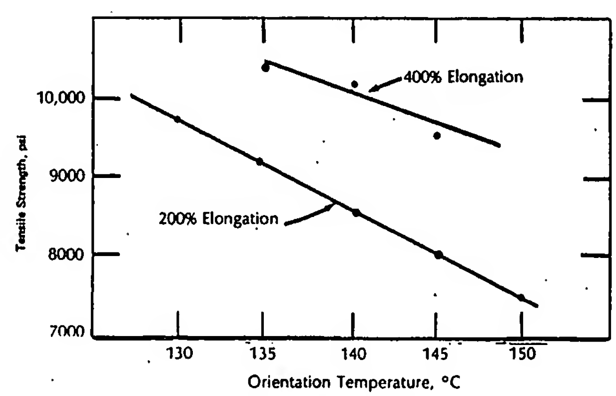


Figure 13. Enchancement of strength through orientation as a function of stretching temperature and percent elongation for polystyrene. (Courtesy SPE Journal.)

The specific orientation temperature will vary from polymer to polymer. It can be determined experimentally, or from the literature. Table 2 describes the second-order transition temperature, the crystalline melting point, and the orientation temperature range.

Table 2.*

Polymer	Second-Order Transition	Crystalline Melting Point	Orientation Temperature
Polyethylene terephthalate	70 C	255 C	85-110 C
Polyhexamethylene adipamide	45-50 C	250 C	67-75 C
Polyhexamethylene sebacamide	45-50 C	250 C	65-75 C
Polycaprolactam	45-50 C	250 C	65-75 C
Polyvinylchloride			
no plasticizer	105 C	170 C	115-145 C
5% plasticizer	90 C	170 C	100-130 C
15% plasticizer	60 C	170 C	70-100 C
Polystyrene	—	—	88-110 C
Polymethylmethacrylate	—	—	66-105 C
Polypropylene (d - .8825)		140 C	100-120 C
Polypropylene (d - .9015)		165 C	125-145 C
Polypropylene (d - .912)		180 C	140-160 C
Polyethylene (d - .92)		110 C	80-110 C
Polyethylene (d - .96)		134 C	120-130 C
Polyvinylflouride (d - 1.4)		193-198 C	175-185 C
Polyoxymethylene (d -1.35)		180-185 C	130-180 C

U.S. PATENT 3,231,643 (to Du Pont, January 15, 1966).

CRYSTALLINE POLYMERS

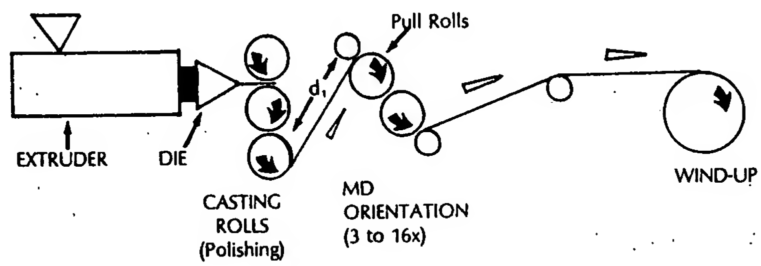
Most of the polymers used in manufacturing shrinkable films are crystallizable polymers. To obtain an orientable tape by extrusion, crystalline polymers must have minimum crystallinity. Therefore, it is necessary to quench as rapidly as possible to below the temperature of crystallization. The material should be cooled below its glass-transition temperature to ensure a low level of crystallinity, or should be cooled to a temperature at which the crystallization rate is low enough that no appreciable amount of crystallinity will develop in the material before it is stretched.

The amorphous or nearly amorphous material is then reheated to as low a temperature as practical above T_g and stretched biaxially very rapidly to prevent crystal growth. (This material can then be quenched to below T_g or to a lower temperature above T_g to give an essentially amorphous, readily heat-shrinkable film). (Table 3)

Table 3. Crystalline Polymers

1.	Extrude
2.	Quench (below crystalline M.P.)
3.	Reheat and/or orient
4.	Anneal (below crystalline M.P.)

Quenching is carried out either by extruding the web onto a chill roll or by passing it through a cold-water bath (Figure 14). Polyethylene terephthalate has a second-order transition point of 70°C and a minimum temperature for crystallization of 90°C, hence the resulting tape is stable. Films, such as polyvinylidene chloride and polypropylene, which have glass-transition temperatures below room temperature, show an appreciable crystallization rate even at room temperature. Accordingly, these films have to be oriented immediately after the formation of the tape, and this is essentially true with vinylidene chloride/vinyl chloride copolymers (Saran™).



(*Note:* Distance d is small to diminish "necking" and improve web control.)

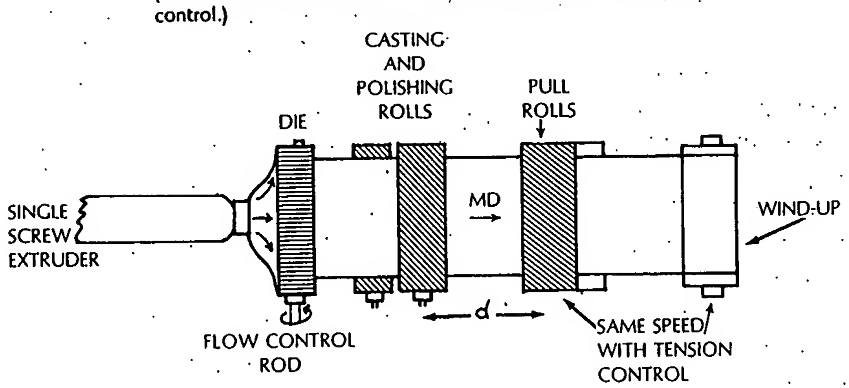


Figure 14. Schematic diagram of sheet extrusion and chill-roll casting unit. (Ref. - Plastics. Films - J. H. Briston Halsted Press. Modern Packaging Films, Edited by S. H. Pinnir Publ. Butterworth, London 1967.)

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BUBBLE PROCESS

The stretching of the polymer sheet or tape can be made either in the longitudinal or transverse direction; in a simultaneous or two-step operation. Two methods have been developed. One is called "bubble process" in which a supercooled tubular film is heated to orientation temperature and stretched by inflation between two sets of pinch rolls running at different speeds. The speed ratio of the rolls controls the orientation in the machine direction (MD) whereas transverse orientation depends on the ratio between final bubble and initial tube diameter. (Figure 15).

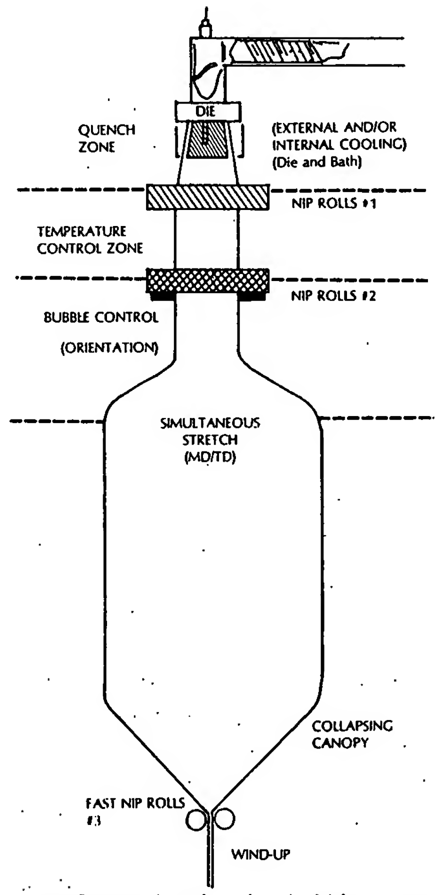

Figure 15. Orientation by the bubble process. Source: Modern Packaging Films, Edited by S. H. Pinnir Publ. Butterworth, London 1967.

For most oriented-film applications it is desirable to have a film as nearly balanced as practicable. This can be regulated by blow-up ratio

and speed ratio of various draw rolls in the apparatus. The illustrations that follow show how one can regulate and balance properties by keeping the blow-up ratio (transverse stretching ratio) constant while increasing the speed of the take-off rolls (machine direction stretch). (Figure 16-19).

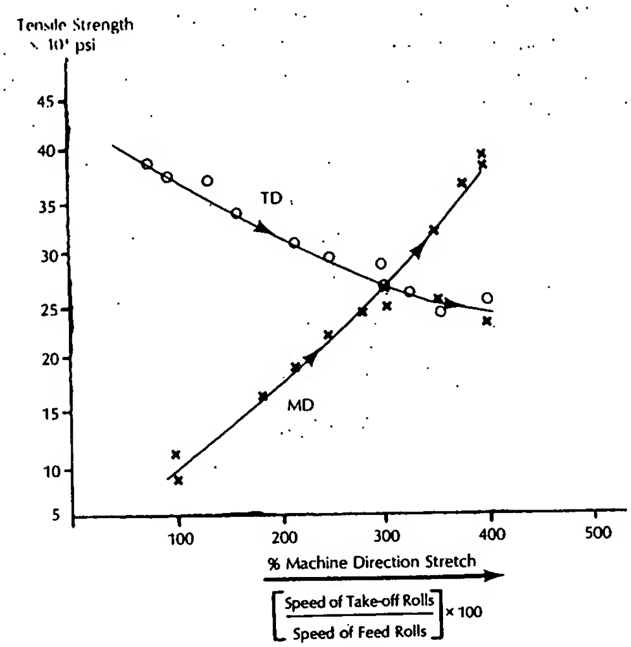

Figure 16. Oriented polypropylene by the bubble process.

TENTER PROCESS

In the second process, the tenterframe operation, the polymer is extruded through a slot die and quenched. Then the sheet is normally oriented in two steps. The first step is usually longitudinal orientation between rolls running at different speeds. In the second stage, the film enters a tenterframe, where it is stretched laterally by means of diverging chains of clips (Figure 20). Whereas the bubble process operates at constant pressure, the tenterframe process operates at a constant rate of elongation. Somewhat higher stretching forces are required in the second stage which may be carried out at slightly higher temperatures. This is mainly due to crystallization of the film during the first stretching operation. The tenterframe process can also be carried out as a simultaneous

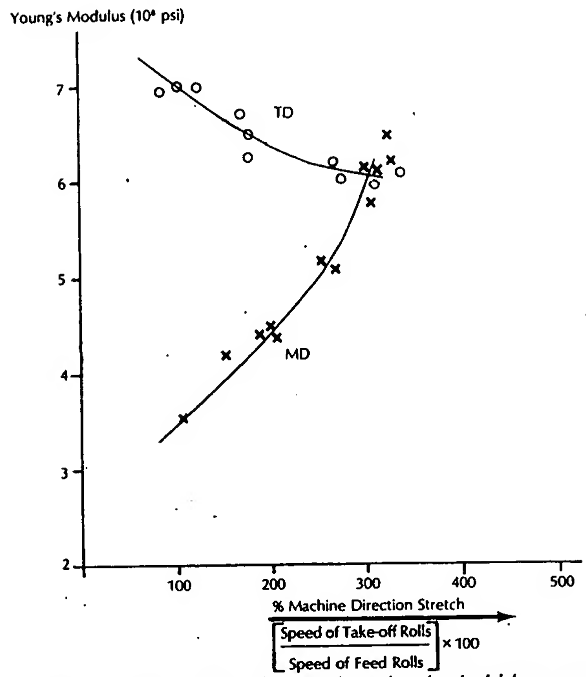

Figure 17. Oriented polypropylene by the bubble process.

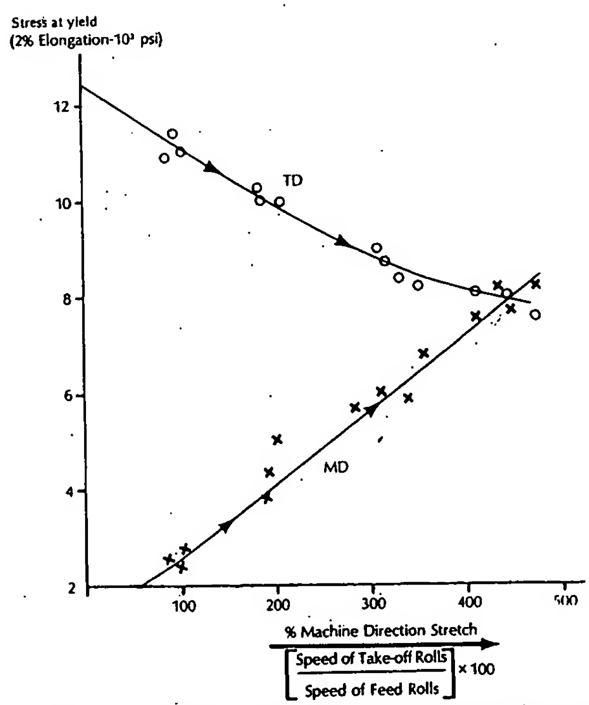

Figure 18. Oriented polypropylene by the bubble process.

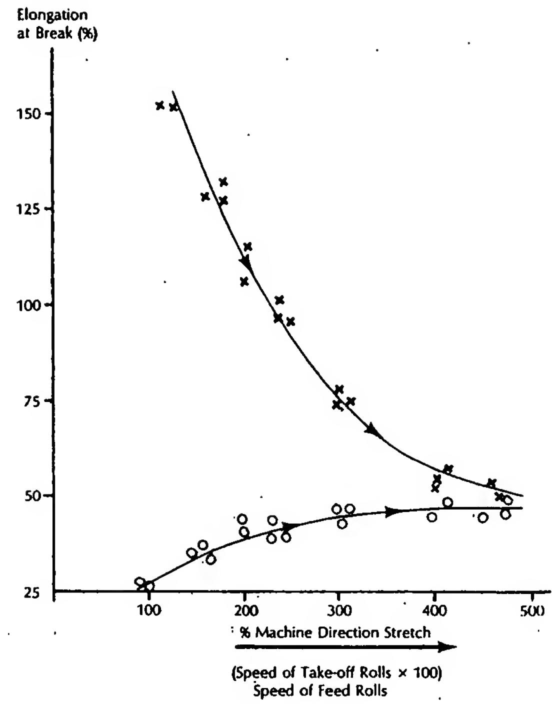

Figure 19. Oriented polypropylene by the bubble process.

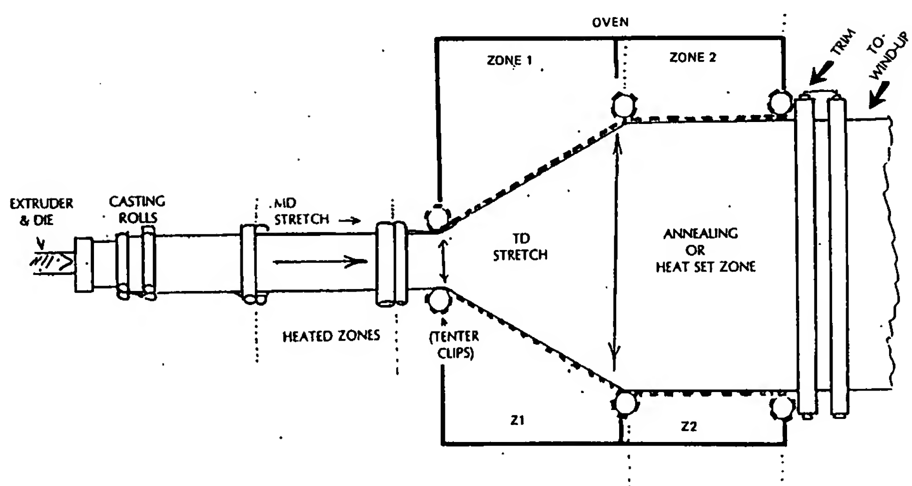

Figure 20. Two-step orientation by tenting (schematic diagram). Source: Modern Packaging Films, Edited by S. H. Pinnir, Publ. Butterworth, London 1967.

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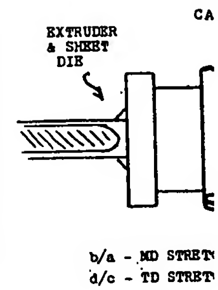

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operation in which an extruded sheet with beaded edges is biaxially oriented in a tenterframe equipped with diverging roller grips for holding and stretching the film (Figure 21).

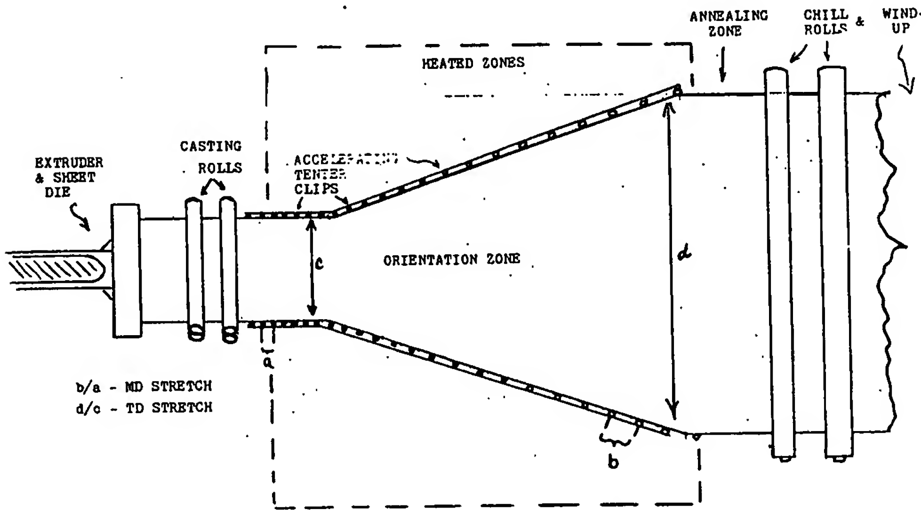

Figure 21. Simultaneous or one-step orientation (schematic diagram). Source: Modern Packaging Films, Edited by S. H. Pinnir, Publ. Butterworth, London 1967.

The tenterframe operation has the advantage of considerable versatility, producing films with a wide range of shrink properties. Both two-stage and simultaneous tenterframe procedures have been employed for orienting polyethylene terephthalate webs, and P.S. biaxially. (This process is required for very stiff materials having very low elongation at failure.)

After stretching, polymer alignment is locked into the film by cooling. When the oriented film is subsequently heated up to temperatures in the vicinity of the stretching temperature, the frozen-in shrinkage stresses become effective and the film shrinks. Strains and stresses which are related to the degree of orientation and the forces which were applied during stretching are thereby recovered.

To obtain a greater degree of heat stabilization, the stretched film is restrained from shrinking, heated to the temperature of its maximum crystallization rate (or higher), and held at this temperature until crystallization has occurred to the desired degree. It is then quenched to room temperature and the restraint on the film is released.

PROCESS COMPARISON

Advantages of the bubble process are:

1. Simultaneous biaxial orientation: process is controllable over a wide temperature range.
2. The bubble symmetry tends to produce even heating and is an important asset in assisting a uniform orientation in both machine drection and cross machine direction.
3. Edge scrap in the bubble process can be negligible since a simple slitting process can be employed.
4. Die design and symmetry is an established art for extrusion of heat sensitive materials.

Points in favor of tenting (two step orientation of flat film):

1. The melt stream is a continuous sheet; there is no seam as one sees in film dies (although these can be eliminated or minimized with vertical extruders and "straight through" dies).
2. Rheology of the melt and stretch behavior can be controlled in a two step orientation.
3. Quenching the film can be achieved more efficiently.
4. Film speeds are higher and gauge control is easily achieved in a tenting operation.
5. The tenting process produces a flatter film.

NON-CRYSTALLINE POLYMERS

Virtually all thermoplastics can be oriented, but one can orient amorphous materials more than crystalline materials. The stretching process frequently induces or increases crystallization particularly where there is some geometric regularity in the molecule. In the past, (prior to 1955) most of our attention was directed to the orientation of amorphous materials and polymers. With the commercialization of the Zeigler-Natta polymer technology, polyolefin research was directed more to the orientation of polyethylene and polypropylene and other low priced polyolefins.

The problem of crystallization is not significant with such polymers as polystyrene (and its copolymers), acrylics, polyesters, and polycarbonates since under normal conditions of polymerization and processing

very little crystallization occurs.

Table 4. Illustrates the Process Steps Involved in the Orientation of Non-Crystalline Polymers

1. Extrude (or Calender)
2. Stretch (Orient)
3. Quench (and/or Anneal)

While PVC is not classified as a crystalline polymer, it is amenable to the manuacture of a relatively high shrink force film by the so-called double bubble process. This process has been used in Europe to produce OPVC. The process consists of an extrusion blown film exiting from the die, with higher than normal blow up ratio, followed by a second bubble of approximately two to one blow-up ratio, which puts the shrink force into the film. (Courtesy of Cryovac Div'n of W. R. Grace).

Author's note

At this point the reader is well aware that one can effectively orient polymeric films and sheet with relative ease. Although hot orientation puts in shrink, it results in very little, if any, shrink tension or force. Orientation at a lower temperature, near but below the crystalline melting point results in high shrink force. Chapter 4 describes the Technology of specific film systems used in packaging.

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In re Francis J.A.M.C. DE BLAUWE and Frank K.A. Selleslags.

Appeal N . 84-513.

United States Court of Appeals, Federal Circuit.

June 8, 1984.

Appeal was taken from a decision of the United States Patent and Trademark Office Board of Appeals affirming examiner's rejection of patent applicants' claims 42–53 and 55–64 of application for patent relating to process of making heat shrinkable articles. The Court of Appeals, Jack R. Miller, Circuit Judge, held that: (1) claims 42–48, 49–51 and 53 were prima facie obvious, but claims 55–64 were not; (2) even if specification had contained objective evidence showing that applicants' heat shrinkable articles did not split, such evidence would not have been a satisfactory showing of unexpected results so as to successfully rebut prima facie showing of obviousness; but (3) despite applicants' arguments that heat shrinkable articles with claimed expansion ratios overcame a long standing splitting problem, Board and examiner merely concluded that those ratios would have been obvious without properly responding to applicants' allegations of unexpected results.

Reversed in part; vacated in part and remanded.

1. Patents ⇐314(5)

Obviousness is question of law to be determined from the facts.

2. Patents ⇐324.55(4)

Conclusion of obviousness is not reviewed under clearly erroneous standard, which is applicable to fact findings; rather, such a conclusion is reviewed for correctness or error as a matter of law.

3. Patents ⇐16.27

Claims 42–48, 49–51 and 53 of application for patent relating to process for making heat shrinkable articles were prima facie obvious, but claims 55–64 were not. 35 U.S.C.A. § 103.

4. Patents ⇐36(1)

Unexpected results, so as to rebut prima facie case of obviousness, must be established by factual evidence; mere argument or conclusory statements in specification does not suffice.

5. Patents ⇐36(3)

Even if specification for application for patent relating to process of making heat shrinkable articles had contained objective evidence showing that applicants' heat shrinkable articles did not split, such evidence would not have been a satisfactory showing of unexpected results so as to rebut prima facie case of obviousness. 35 U.S.C.A. § 103.

6. Patents ⇐26(2)

When an article is said to achieve unexpected results, those results must logically be shown as superior compared to results achieved with other articles.

7. Patents ⇐16.5

Patent applicant relying on comparative tests to rebut prima facie case of obviousness must compare his claimed invention to the closest prior art.

8. Patents ⇐113(6)

Solicitor cannot raise new ground of rejection or apply new rationale to support

consent cannot *dictate* the decision which the PTO must make on the issue of likelihood of confusion. It is simply a factor to be taken into consideration. *In re E.I. DuPont deNemours,* 476 F.2d 1357, 1362, 117 USPQ 563, 568 (CCPA 1973); *In re Continental Baking Co.,* 390 F.2d 747, 156 USPQ 514 (CCPA 1968); accord, *Selva & Sons, Inc. v. Nina Footwear, Inc.,* 705 F.2d 1316, 1324, 217 USPQ 641, 647 (Fed.Cir.1983). Regardless of what private arrangement may exist between parties, no one has a right to a registration contrary to the statute. *Danskin, Inc. v. Dan River, Inc.,* 498 F.2d 1386, 182 USPQ 370 (CCPA 1974), relied on by appellant, did not overrule this general principle.

Ex F

rejection in appeals from decisions of Patent and Trademark Office Board of Appeals.

9. Patents ⇐16(1)

Claimed invention must be considered as a whole in deciding question of obviousness.

10. Patents ⇐36(1)

A proper showing of unexpected results will rebut a prima facie case of obviousness.

11. Patents ⇐113(8)

Patent and Trademark Office Board of Appeals and examiner, though correctly concluding that invention was prima facie obvious, did not properly respond to patent applicants' allegations of unexpected results to rebut that prima facie case where they failed to challenge the sufficiency of applicants' rebuttal evidence until appeal; therefore, board's decision on claims 42–51 and 53 of application for patent relating to process of making each heat shrinkable articles would be vacated.

Jeffrey G. Sheldon, Pasadena, Cal., argued for appellants.

John F. Pitrelli, Arlington, Va., argued for appellee. With him on the brief were Joseph F. Nakamura, Sol., and John W. Dewhirst, Associate Sol., Washington, D.C.

Before BENNETT, Circuit Judge, SKELTON, Senior Circuit Judge, and MILLER, Circuit Judge.

JACK R. MILLER, Circuit Judge.

This appeal is from that part of the decision of the United States Patent and Trademark Office ("PTO") Board of Appeals ("board") which affirms the examiner's rejection of appellants' claims[1] 42–53 and 55–64 under 35 U.S.C. § 103. We reverse in part, vacate in part, and remand.

THE INVENTION

Appellants' claims are drawn to heat shrinkable (or recoverable) articles and methods of utilizing these articles. Heat shrinkable articles, which are well known in the art, are often shaped as a hollow tube, having two open ends, or a hollow cap, having an open end and a closed end. They are used as protective coatings for pipes, electrical cables, and telephone cables by positioning the heat shrinkable article over the pipe or cable and then applying heat to shrink the article into contact with the pipe or cable. The following polymeric materials are useful in manufacturing heat shrinkable articles: polyolefins, copolymers of ethylene and vinyl acetate, copolymers of ethylene and ethyl acrylate, chlorinated or fluorinated polymers; also, ethylene-propylene, or chlorinated, or silicone rubber.

Heat shrinkable articles are typically made by the following process: (1) melt-shaping a polymeric material into an article having an original shape, (2) cross-linking the shaped article, (3) heating the cross-linked article above the melting temperature of the polymeric material, (4) expanding the heated article into a new shape, and (5) cooling the article while maintaining its expanded new shape. When an article made by this method is heated above the melting point of the polymeric material, it shrinks back to its original shape. The extent of expansion during step (4) of the above process is indicated by the expansion ratio of a dimension (often diameter) after expansion to the same dimension before expansion (i.e. when the article had its original shape).

One problem encountered in prior heat shrinkable articles is their tendency to split during expansion or shrinkage if the article has a high expansion ratio. Splitting usually occurs at the open end(s) of such articles and is especially acute if the article has a nick or notch which tends to propagate during shrinkage. Appellants state that, although the expansion ratio at which split-

1. In application serial No. 071,762, filed August 31, 1979, for: "Heat-recoverable Article [sic, Articles]," which is a continuation of serial No. 849,214, filed November 7, 1977, and now abandoned.

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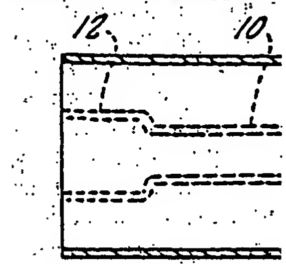

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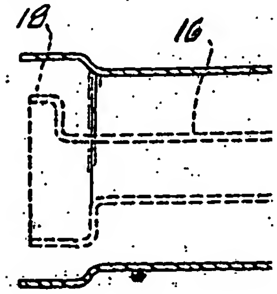

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ting occurs depends on the type of polymer utilized, there is rarely a problem with expansion ratios below 2.5 and usually ratios up to 3.0 can be safely used. However, they indicate that splitting becomes a problem with expansion ratios of 3.5 or higher.

Appellants have discovered that splitting is avoided, even when high expansion ratios are utilized, if the article is provided with open end sections having relatively low expansion ratios. Figure 1 shows an example of a tube-shaped heat shrinkable article in accordance with appellants' invention.

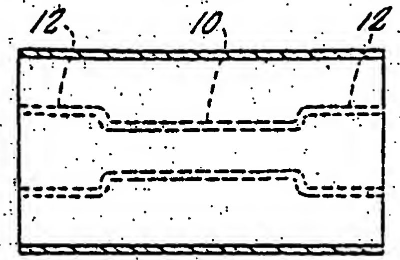

FIG. 1

The solid lines show the article's shape before heat shrinkage, while the dotted lines depict the article's configuration after heat shrinkage. The article assumes an hour glass shape after heat shrinkage because intermediate section 10 has a higher expansion ratio than end sections 12. Likewise, when appellants' articles are in the form of an end cap, as shown in Fig. 2 below, the hour glass shape depicted by the dotted lines results after heat shrinkage, because intermediate section 16 has a higher expansion ratio than open end section 18 and closed end section 20.

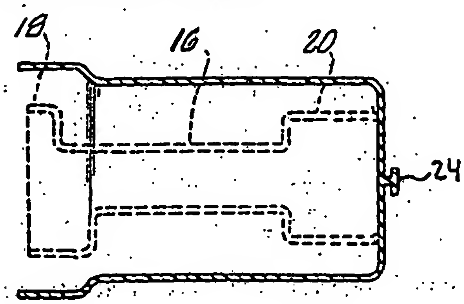

FIG. 2

Element 24 in Fig. 2 is a gripping protuberance by which end section 20 of the end cap can be grasped when it is in the interior of conduit 22, as shown below in Fig. 3, to permit this section to be pulled out f the conduit's interior.[2]

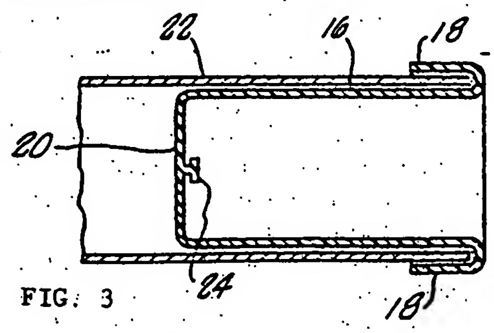

FIG. 3

The following claims are illustrative:

42. A hollow heat-shrinkable article composed of a polymeric material and having a closed cross-section and at least one open end, each open end being defined by an open end section having adjacent thereto an intermediate section, the open end section having a first expansion ratio which is from 1 to 3.0 and the intermediate section having a second expansion ratio which is at least 3.0 and at least 0.5 greater than said first expansion ratio, whereby the amount of available recovery in the open end section is substantially less than the amount of available recovery in the intermediate section, the circumference of the open end section after unrestrained recovery of the article being substantially greater than the circumference of the intermediate section.

55. [Rewritten in independent form for purposes of this appeal] A method of covering a part of an elongate substrate which comprises the steps of:

(a) placing around said part of the substrate at least part of a hollow heat-shrinkable article composed of a polymeric material and having at least one open end, each open end being defined by an open end section having adjacent

2. Figures 1, 2, and 3 are not part of appellants' application but were included in appellants' brief for purposes of illustration.

thereto an intermediate section, the open end section having a first expansion ratio which is from 1.0 to 3.0 and the intermediate section comprising a region having a second expansion ratio which is at least 3.0 and at least 0.5 greater than said first expansion ratio, whereby the amount of available recovery in the open end section is substantially less than the amount of available recovery in the intermediate section adjacent thereto, at least an open end section and an adjacent intermediate section of the article being placed around the substrate; and

(b) heating said open end section and said intermediate section of said article to cause shrinkage of said intermediate section into contact with the substrate and to cause shrinkage of said open end section to form a collar which flares out of contact with the substrate.

59. A method of providing an end cap on a hollow conduit which comprises the steps of:

(a) placing around the end of the hollow conduit the open end section only of a heat-shrinkable tubular cap comprising an open end section defining the open end of the cap and having a first expansion ratio, an intermediate section adjacent said open end section and having a second expansion ratio and a closed end section having a third expansion ratio, the second expansion ratio being greater than the first and third expansion ratios; and

(b) heating said open end section to cause shrinkage thereof into contact with the conduit without causing substantial shrinkage of the remainder of the cap.

Claims 52 and 61, which indirectly depend from claims 42 and 59, respectively, require that the article have "a gripping protuberance on the outside of the closed end section." [3] Claim 60, which depends from claim 59, calls for the further step of pushing the end cap along its axis so that the closed end and intermediate sections are telescoped through the open end section into the interior of the hollow conduit where they remain during heating (see Fig. 3 supra). The other claims before us are also dependent claims, which further limit the values of the expansion ratios, specify the article's dimensions, describe the material from which the article is made, specify the number of open and closed ends in the article, or set forth further steps for utilizing the end cap.

THE PRIOR ART

United States patent No. 3,526,683 to Heslop et al. ("Heslop") discloses a method of forming a heat recoverable article having different degrees of heat recovery at different parts of the article by a process similar to that taught by appellants. Heslop's articles are particularly useful as sleeves for parts with irregular dimensions such as an insulator for a splice between different size wires, where the article undergoes heat recovery to conform to the shape of the part. In one embodiment of Heslop, a tubular article is cross-linked at an intermediate section thereof, heated, expanded in diameter to the shape shown in Fig. 4 below, and then heat recovered to the shape depicted in Fig. 5 below.

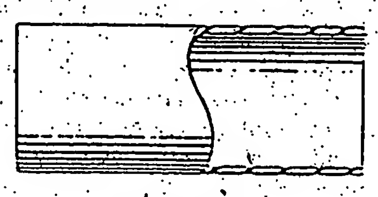

FIG. 4.

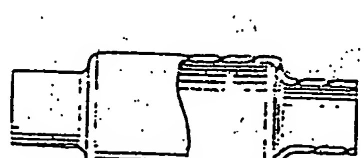

FIG. 5.

Heslop's example I indicates that tubular articles, like that of Fig. 4, can have open

3. Claim 52 depends directly from claim 49 which provides an antecedent basis for "the closed end section."

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United States pa
Meyer discloses hea
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United States pa
Beinhaur discloses a
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BOARD

The board affirmed
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U.S.C. § 103 stating:

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4. Appellants do not ap
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end sections with expansion ratios of 3.33, and an intermediate section with an expansion ratio of 1.9.

United States patent No. 3,847,183 to Meyer discloses heat recoverable closures for protecting cables from moisture penetration. The ends of the cables are protected by end caps having an open end and a closed end, while cables spliced together are encased in a cylindrical sleeve having two open ends.

United States patent No. 3,992,570 to Beinhaur discloses a rubber end cap which is placed over the end of a cable by axially aligning the closed end of the cap and the end of the cable and forcing the remainder of the cap over the closed end and over the exterior of the cable so that the cap is turned inside out.

BOARD OPINION

The board affirmed the examiner's rejection of claims 35–40 and 42–67[4] under 35 U.S.C. § 103 stating:

> [I]t is evident from Heslop that hollow heat-shrinkable articles having variant sections of independent and different heat-shrinkability are known so that they may be used as a sleeve to encapsulate various irregularly shaped forms. The fact that in the specific embodiments of Heslop the expansion ratios of the open and intermediate sections are in reverse order than [sic, from] those claimed is not seen to distract from its value as a reference to suggest the instantly claimed invention. It clearly would be apparent to the average routineer in this field that either the end or intermediate sections could be made to have a greater or smaller expansion ratio, respectively, depending on a particular application to which the article is to be put.

As to appellants' argument that their articles do not split, the board concluded:

> Only the obvious result is achieved by appellant [sic, appellants] by selecting an expansion ratio of the open end to be smaller than the expansion ratio of the intermediate section.
>
> ....
>
> ... Although the reason for appellants' modification finds no response in the art, nevertheless, the art is suggestive of the claimed variations and, accordingly, no patentable distinctiveness can lie on this basis....

The board also concluded that the teachings of Meyer and Beinhaur would have been properly combinable with those of Heslop to provide Heslop's article with a closed end section and to telescopically insert a cable sealing device, respectively.

ANALYSIS

[1, 2] At the outset, we caution the Solicitor that obviousness is a question of law to be determined from the facts. *Stratoflex, Inc. v. Aeroquip Corp.*, 713 F.2d 1530, 1535, 218 USPQ 871, 876 (Fed.Cir.1983); *Stevenson v. International Trade Commission*, 612 F.2d 546, 549, 204 USPQ 276, 279 (CCPA 1979); *In re May*, 574 F.2d 1082, 1089, 197 USPQ 601, 606–07 (CCPA 1978). A conclusion of obviousness is not reviewed under the clearly erroneous standard, which is applicable to fact findings. *See Raytheon Co. v. Roper Corp.*, 724 F.2d 951, 220 USPQ 592 (Fed.Cir.1983). Rather, such a conclusion is reviewed for correctness or error as a matter of law. *In re Carleton*, 599 F.2d 1021, 1024 n. 14, 202 USPQ 165, 169 n. 14 (CCPA 1979).

1. *Prima Facie Obviousness*

[3] With respect to claims 42–48, we agree with the board that it would have been prima facie obvious to reverse the order of the expansion ratios in Heslop's article so that it would have an hour glass shape after heat recovery. Although the heat shrinkable articles in Figs. 4 and 5 of Heslop has an arrangement of expansion

4. Appellants do not appeal the board's decision sustaining the examiner's rejection of claims 35–40, 54, and 65–67.

ratios opposite to that of appellants' article, Heslop teaches the broad concept of producing heat shrinkable articles with portions having different expansion ratios so that the articles conform to parts with irregular dimensions after heat recovery. When a portion of the part to be covered has a smaller diameter than that of its surrounding portions, which are also to be covered, we are satisfied that it would have been prima facie obvious to one of ordinary skill in the art, from the teachings of Heslop, to utilize a heat shrinkable article with expansion ratios permitting its recovery to an hour glass shape.

We also agree with the board that it would have been prima facie obvious to close one end of Heslop's heat shrinkable articles to form an end cap, as specified by claims 49–51 and 53. It is well known to make heat shrinkable articles in the shape of end caps rather than tubes when sealing the end of a single wire rather than two spliced wires, as taught by Meyer. However, as admitted by the Solicitor at oral argument, the combination of Heslop and Meyer fails to suggest providing a gripping protuberance on the outside of the closed end, and, therefore, the board's decision with respect to claim 52 is erroneous as a matter of law.

We agree with appellants that the references would have failed to suggest to one of ordinary skill in the art the steps of: heating to form a collar at the open end section which flares out of contact with the part being covered (claim 55) and heating the open end section of an end cap to cause shrinkage of the open end section without shrinking the remainder of the cap (claim 59). Accordingly, the board's approval of the rejection of these independent claims, along with their dependent claims 56–58 and 60–64, respectively, is erroneous as a matter of law.[5]

2. *Unexpected Results*

Appellants argue that, even if the PTO established a prima facie case of obviousness, it has been rebutted, because the claimed invention unexpectedly overcomes the splitting problem discussed supra. Also, they point out that the prior art of record does not suggest avoiding the splitting problem by utilizing appellants' technique.

In response to appellants' assertions of unexpected results, the Solicitor states in his brief: "There is no *objective evidence* in the record that 'no splitting' is, in fact, a result of their claimed invention, much less that it is unexpected."

In their reply brief, appellants argue that their assertions of unexpected results *are* supported by objective evidence. Specifically, appellants rely on the following passages in their specification:

> On the other hand, in order fully to utilise the advantages of the present invention, the second region generally exhibits a high degree of available recovery. The expansion ratios which will, in the absence of end sections as required by the present invention[,] lead to splitting on shrinkage are dependent *inter alia* on the polymer employed and the thickness. There is seldom a problem with expansion ratios below 2.5, and usually expansion ratios of up to 3.0 can safely be used. However, at expansion ratios of 3.5 or higher splitting is usually a problem and this applies more so at ratios of 4.0, 4.5 and 5.0. Thus the present invention is especially applicable at ratios of from 4 to 6 and above, for example up to 10, i.e. where the amount of available recovery is from 400% to 1000%, usually from 400% to 600%, especially when the percentage of unresolved recovery after shrinkage is high.
>
> ....
>
> ... Typical dimensions, in inches, of three such end caps are as follows:

5. In view of our decision to reverse the PTO's rejection of claim 60, we need not decide whether Beinhaur meets the limitations of claim 60. Although our reversal of the board's affirmance of the rejection of claim 59 also makes further consideration of claim 61 unnecessary, we note that claim 61 is also patentable, because, like

Cap No.	Interme Section Diamete After Shrinka (a)
1	0.8
2	1.5
3	2.5

(1) b ÷ d;
(2) a ÷ d; c

It is appellants' positi
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evidence that the spli
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this problem. We disa

[4] It is well settl
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173 USPQ 356, 358 (
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[5–7] Even if th
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6. The table in the specif
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forth in the latter.

Cap No.	Intermediate Section Diameter After Shrinkage (a)	Cap Diameter Before Shrinkage (b)	End Section Diameter After Shrinkage (d)	End Section Expansion Ratio (1)	Intermediate Section Expansion Ratio (2)
1	0.8	4.0	2.8	1.4	5
2	1.5	6.0	3.5	1.7	4
3	2.5	8.0	4.5	1.8	3.2

(1) b ÷ d; claim 42 range is 1 to 3
(2) a ÷ d; claim 42 range is greater than 3 [6]

It is appellants' position that the combination of these passages constitutes objective evidence that the splitting problem exists and that the claimed invention overcomes this problem. We disagree.

[4] It is well settled that unexpected results must be established by factual evidence. Mere argument or conclusory statements in the specification does not suffice. *In re Lindner*, 457 F.2d 506, 508, 173 USPQ 356, 358 (CCPA 1972). Here, appellants' table of "[t]ypical dimensions" is devoid of any data from which we can determine whether or not the end caps described therein actually split. In essence, appellants ask us to *assume* that the end caps in this table are nonsplitting, because a preceding passage in the specification concludes that no splitting occurs in such articles. Examples requiring such assumptions can hardly be considered factual evidence.

[5–7] Even if the specification contained objective evidence showing that appellants' heat shrinkable articles do not split, such evidence would not be a satisfactory showing of unexpected results. When an article is said to achieve unexpected (i.e. superior) results, those results must logically be shown as superior *compared* to the results achieved with other articles. *In re Swentzel*, 219 F.2d 216, 220, 104 USPQ 343, 346 (CCPA 1955). *See also In re Palmer*, 451 F.2d 1100, 1102, 172 USPQ 126, 128 (CCPA 1971). Moreover, an applicant relying on comparative tests to rebut a prima facie case of obviousness must compare his claimed invention to the closest prior art. *In re Merchant*, 575 F.2d 865, 869, 197 USPQ 785, 788 (CCPA 1978). Here, appellants have not presented any experimental data showing that prior heat shrinkable articles split. Due to the absence of tests comparing appellants' heat shrinkable articles with those of the closest prior art, we conclude that appellants' assertions of unexpected results constitute mere argument and conclusory statements in the specification which cannot establish patentability. *Lindner*, *supra*; *In re Wood*, 582 F.2d 638, 642, 199 USPQ 137, 140 (CCPA 1978).

[8] Appellants complain, however, that the PTO challenges their assertions of unexpected results for the first time in the Solicitor's brief.[7] They contend that, if we are persuaded by the PTO's position, prose-

claim 52, it provides for a gripping protuberance.

6. The table in the specification differs from that shown above in that the latter sets forth expansion ratios and contains some explanatory information not included in the former, while the former includes additional dimensions not set forth in the latter.

7. It is true that the Solicitor cannot raise a new ground of rejection or apply a new rationale to support a rejection in appeals from decisions of the board. *In re Strahilevitz*, 668 F.2d 1229, 212 USPQ 561 (CCPA 1982). However, we cannot ignore the substance of the Solicitor's arguments and reverse the board in the face of a prima facie case of obviousness unrebutted by objective evidence. At the same time, an af-

cution should be reopened so that affidavits showing unexpected results can be filed.

[9–11] It is elementary that the claimed invention must be considered as a *whole* in deciding the question of obviousness. *In re Kaslow,* 707 F.2d 1366, 217 USPQ 1089 (Fed.Cir.1983); *Stratoflex,* 713 F.2d at 1537, 218 USPQ at 877. Although the board and the examiner correctly concluded that the invention of claims 42–51 and 53 would have been prima facie obvious, this conclusion did not properly end consideration of the obviousness question; evidence arising out of secondary considerations must always be considered. *Stratoflex, supra; In re Sernaker,* 702 F.2d 989, 996, 217 USPQ 1, 7 (Fed.Cir.1983).[8] Despite appellants' arguments throughout prosecution that heat shrinkable articles with the claimed expansion ratios overcome the longstanding splitting problem, the board and the examiner merely concluded that these ratios would have been obvious without properly responding to appellants' allegations of unexpected results. Although appellants failed to make an adequate showing of unexpected results, if the board or the examiner had considered this point when the case was pending before them and had pointed out that there was no objective evidence of unexpected results, appellants would, at least, have had notice and would have had an opportunity to file objective evidence.[9] Neither the board nor the examiner, however, gave such notice, and, therefore, appellants were led to believe, albeit erroneously, that they had satisfied their burden of going forward with objective evidence to rebut the prima facie case of obviousness. *In re Rinehart,* 531 F.2d 1048, 189 USPQ 143 (CCPA 1976). In view of the PTO's failure to challenge the sufficiency of appellants' rebuttal evidence until this appeal, when appellants could no longer offer evidence, we conclude that it is necessary to vacate the board's decision on claims 42–51 and 53 and to remand the case to afford appellants the opportunity to submit objective evidence of unexpected results. *See In re Wiechert,* 370 F.2d 927, 933, 152 USPQ 247, 251–52 (CCPA 1967).

SUMMARY

The decision of the board is *reversed* with respect to claims 52 and 55–64 and *vacated* with respect to claims 42–51 and 53. The case is *remanded* for further proceedings consistent with this opinion.

REVERSED-IN-PART; VACATED-IN-PART; and REMANDED.

MISSOURI PACIFIC TRUCK LINES, INC., Appellee,

v.

The UNITED STATES, Appellant.

Appeal No. 84–604.

United States Court of Appeals, Federal Circuit.

June 20, 1984.

Appealed from U.S. Claims Court; Nettesheim, Judge.

firmance is not appropriate in view of the PTO's conduct, discussed infra.

8. A proper showing of unexpected results will rebut a prima facie case of obviousness. *In re Fenn,* 639 F.2d 762, 208 USPQ 470 (CCPA 1981); *In re Murch,* 464 F.2d 1051, 175 USPQ 89 (CCPA 1972).

9. Examiners will consider an affidavit or declaration under 37 C.F.R. § 1.132 if submitted prior to final rejection or with the first response after final rejection for the purpose of overcoming a new ground of rejection or requirement made in the final rejection. *United States Patent and Trademark Office, Manual of Patent Examining Procedure* § 716 (4th ed. rev. 1982). Affidavits or declarations filed after final rejection will be considered if a satisfactory showing under 37 C.F.R. § 1.116(b) or 37 C.F.R. § 1.195 is made. *Id.* Where the board makes a decision advancing a position or rationale new to the proceedings, an applicant must be afforded an opportunity to respond to that position or rationale by submission of contradicting evidence. *In re Eynde,* 480 F.2d 1364, 178 USPQ 470 (CCPA 1973). Accordingly, if the board or the examiner in this case had stated that there was no objective evidence, appellants would have been entitled to respond by filing such evidence.

MI

George L. Squires
gued for appellant.
were Glenn L. Arche
Michael L. Paup an
Washington, D.C.

William M. Paul,
gued for appellee.
was John B. Jones,

Before MARKE
FRIEDMAN and
Judges.

tions. It merely prevents Chromalloy from asserting that KGL's right to use such a composite mark is barred by the decree. Rather than resolving the issue of likelihood of confusion with respect to such marks, the issue is left open except with respect to the trade name and mark KENNETH GORDON, to which KGL obtained a clear concession, considering the decree as a whole.

[3] While the decree is not a model of clarity, given the issues before the court in the civil action, we conclude without any equivocation that no consent was given by Chromalloy to KGL's use or registration of the subject mark, LADY GORDON for women's clothing.[4]

Reversed and Remanded

[4] The author adds the personal comment that unless the principles of res judicata discussed above apply, a consent given in a decree should be treated as any other contractual consent. A consent cannot *dictate* the decision which the PTO must make on the issue of likelihood of confusion. It is simply a factor to be taken into consideration. In re E. I. DuPont deNemours, 476 F.2d 1357, 1362, 117 USPQ 563, 568 (CCPA 1973); In re Continental Baking Co., 390 F.2d 747, 156 USPQ 514 (CCPA 1968); accord, Selva & Sons, Inc. v. Nina Footwear, Inc., 705 F.2d 1316, 1324, 217 USPQ 641, 647 (Fed. Cir. 1983). Regardless of what private arrangement may exist between parties, no one has a right to a registration contrary to the statute. Danskin, Inc. v. Dan River, Inc., 498 F.2d 1386, 182 USPQ 370 (CCPA 1974), relied on by appellant, did not overrule this general principle.

Court of Appeals, Federal Circuit

In re De Blauwe et al.

No. 84-513

Decided June 8, 1984

PATENTS

1. Patentability — Invention — Law or fact question (§51.507)

Obviousness is question of law to be determined from facts.

2. Court of Appeals for the Federal Circuit — Weight given decision reviewed (§26.59)

Conclusion of obviousness is not reviewed under "clearly erroneous" standard, which is applicable to fact findings; rather, such conclusion is reviewed for correctness or error as matter of law.

3. Patentability — Evidence of — In general (§51.451)

Unexpected results must be established by factual evidence; mere argument or conclusory statements in specification does not suffice.

4. Patentability — Evidence of — In general (§51.451)

Patentability — Invention — In general (§51.501)

When article is said to achieve unexpected, that is, superior, results, those results must logically be shown as superior compared to results achieved with other articles; moreover, applicant relying on comparative tests to rebut prima facie case of obviousness must compare his claimed invention to closest prior art.

5. Court of Appeals for the Federal Circuit — Issues determined (§26.53)

Solicitor cannot raise new ground of rejection or apply new rationale to support rejection in appeals from decisions of Board of Appeals; however substance of Solicitor's arguments cannot be ignored, and board cannot be reversed in face of prima facie case of obviousness unrebutted by objective evidence.

6. Patentability — Invention — In general (§51.501)

Claimed invention must be considered as whole in deciding question of obviousness; proper showing of unexpected results will rebut prima facie case of obviousness.

7. Patentability — Evidence of — In general (§51.451)

Evidence arising out of secondary considerations must always be considered.

8. Board of Appeals — Procedure and practice (§19.45)

Pleading and Practice in Patent Office — In general (§54.1)

Examiners will consider affidavit or declaration under 37 CFR 132, if submitted prior to final rejection or with first response after final rejection for purpose of overcoming new ground of rejection or requirement made in final rejection; affidavits or declarations filed after final rejection are considered if satisfactory showing under 37 CFR 116(b) or 37 CFR 195 is made; where Board of Appeals

makes decision advancing position or rationale new to proceedings, applicant must be afforded opportunity to respond to that position or rationale by submission of contradicting evidence.

9. Court of Appeals for the Federal Circuit — Pleading and practice (§26.57)

PTO's failure to challenge sufficiency of applicant's rebuttal evidence until appeal to CAFC when they could no longer offer evidence, requires that Board of Appeals decision be vacated and case remanded to afford applicants opportunity to submit evidence of unexpected results.

Particular patents — Heat Shrinkable Articles

De Blauwe and Selleslags, Heat-recoverable Article, rejection of claims 52, and 55-64 reversed; rejection of claims 42-51 and 53 vacated.

Appeal from Patent and Trademark Office Board of Appeals.

Application for patent of Francis J.A.M.C. De Blauwe, and Frank K.A. Selleslags, filed Aug. 31, 1979, continuation of application, Serial No. 849,214, filed Nov. 7, 1977, abandoned. From decision rejecting claims 42-53 and 55-64, applicants appeal. Modified.

Jeffrey G. Sheldon, Pasadena, Calif., for appellants.

John F. Pitrelli (Joseph F. Nakamura, and John W. Dewhirst, on the brief) for Patent and Trademark Office.

Before Bennett, and Miller, Circuit Judges, and Skelton, Senior Circuit Judge.

Miller, Circuit Judge.

This appeal is from that part of the decision of the United States Patent and Trademark Office ("PTO") Board of Appeals ("board") which affirms the examiner's rejection of appellants' claims[1] 42-53 and 55-64 under 35 U.S.C. §103. We reverse in part, vacate in part, and remand.

The Invention

Appellants' claims are drawn to heat shrinkable (or recoverable) articles and methods of utilizing these articles. Heat shrinkable articles, which are well known in the art, are often shaped as a hollow tube, having two open ends, or a hollow cap, having an open end and a closed end. They are used as protective coatings for pipes, electrical cables, and telephone cables by positioning the heat shrinkable article over the pipe or cable and then applying heat to shrink the article into contact with the pipe or cable. The following polymeric materials are useful in manufacturing heat shrinkable articles: polyolefins, copolymers of ethylene and vinyl acetate, copolymers of ethylene and ethyl acrylate, chlorinated or fluorinated polymers; also, ethylene-propylene, or chlorinated, or silicone rubber.

Heat shrinkable articles are typically made by the following process: (1) melt-shaping a polymeric material into an article having an original shape, (2) cross-linking the shaped article, (3) heating the cross-linked article above the melting temperature of the polymeric material, (4) expanding the heated article into a new shape, and (5) cooling the article while maintaining its expanded new shape. When an article made by this method is heated above the melting point of the polymeric material, it shrinks back to its original shape. The extent of expansion during step (4) of the above process is indicated by the expansion ratio of a dimension (often diameter) after expansion to the same dimension before expansion (i.e. when the article had its original shape).

One problem encountered in prior heat shrinkable articles is their tendency to split during expansion or shrinkage if the article has a high expansion ratio. Splitting usually occurs at the open end(s) of such articles and is especially acute if the article has a nick or notch which tends to propagate during shrinkage. Appellants state that, although the expansion ratio at which splitting occurs depends on the type of polymer utilized, there is rarely a problem with expansion ratios below 2.5 and usually ratios up to 3.0 can be safely used. However, they indicate that splitting becomes a problem with expansion ratios of 3.5 or higher.

Appellants have discovered that splitting is avoided, even when high expansion ratios are utilized, if the article is provided with open end sections having relatively low expansion ratios. Figure 1 shows an example of a tube-shaped heat shrinkable article in accordance with appellants' invention.

---

[1] In application serial No. 071,762, filed August 31, 1979, for "Heat-recoverable Article [sic, Articles]," which is a continuation of serial No. 849,214, filed November 7, 1977, and now abandoned.

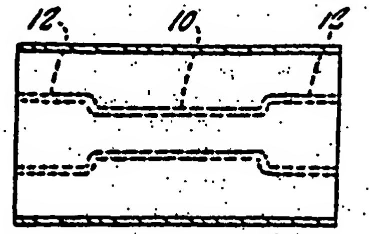

FIG. 1

The solid lines show the article's shape before heat shrinkage, while the dotted lines depict the article's configuration after heat shrinkage. The article assumes an hour glass shape after heat shrinkage because intermediate section 10 has a higher expansion ratio than end sections 12. Likewise, when appellants' articles are in the form of an end cap, as shown in Fig. 2 below, the hour glass shape depicted by the dotted lines results after heat shrinkage, because intermediate section 16 has a higher expansion ratio than open end section 18 and closed end section 20.

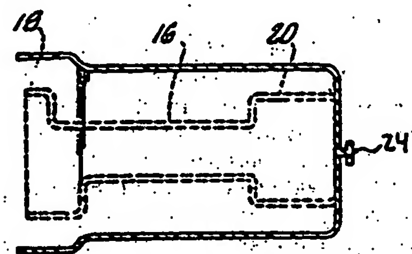

FIG. 2

Element 24 in Fig. 2 is a gripping protuberance by which end section 20 of the end cap can be grasped when it is in the interior of conduit 22, as shown below in Fig. 3, to permit this section to be pulled out of the conduit's interior.[2]

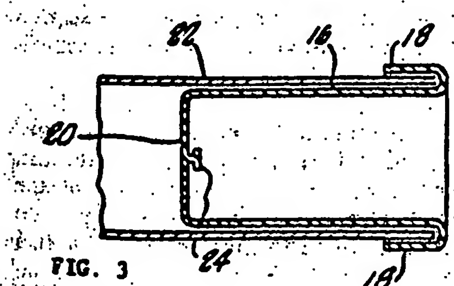

FIG. 3

[2] Figures 1, 2, and 3 are not part of appellants' application but were included in appellants' brief for purposes of illustration.

The following claims are illustrative:

42. A hollow heat-shrinkable article composed of a polymeric material and having a closed cross-section and at least one open end, each open end being defined by an open end section having adjacent thereto an intermediate section, the open end section having a first expansion ratio which is from 1 to 3.0 and the intermediate section having a second expansion ratio which is at least 3.0 and at least 0.5 greater than said first expansion ratio, whereby the amount of available recovery in the open end section is substantially less than the amount of available recovery in the intermediate section, the circumference of the open end section after unrestrained recovery of the article being substantially greater than the circumference of the intermediate section.

55. [Rewritten in independent form for purposes of this appeal] A method of covering a part of an elongate substrate which comprises the steps of:

(a) placing around said part of the substrate at least part of a hollow heat-shrinkable article composed of a polymeric material and having at least one open end, each open end being defined by an open end section having adjacent thereto an intermediate section, the open end section having a first expansion ratio which is from 1.0 to 3.0 and the intermediate section comprising a region having a second expansion ratio which is at least 3.0 and at least 0.5 greater than said first expansion ratio, whereby the amount of available recovery in the open end section is substantially less than the amount of available recovery in the intermediate section adjacent thereto, at least an open end section and an adjacent intermediate section of the article being placed around the substrate; and

(b) heating said open end section and said intermediate section of said article to cause shrinkage of said intermediate section into contact with the substrate and to cause shrinkage of said open end section to form a collar which flares out of contact with the substrate.

59. A method of providing an end cap on a hollow conduit which comprises the steps of:

(a) placing around the end of the hollow conduit the open end section only of a heat-shrinkable tubular cap comprising an open end section defining the open end of the cap and having a first expansion ratio, an intermediate section adjacent said open end

section and having a second expansion ratio and a closed end section having a third expansion ratio, the second expansion ratio being greater than the first and third expansion ratios; and

(b) heating said open end section to cause shrinkage thereof into contact with the conduit without causing substantial shrinkage of the remainder of the cap.

Claims 52 and 61, which indirectly depend from claims 42 and 59, respectively, require that the article have "a gripping protuberance on the outside of the closed end section."[3] Claim 60, which depends from claim 59, calls for the further step of pushing the end cap along its axis so that the closed end and intermediate sections are telescoped through the open end section into the interior of the hollow conduit where they remain during heating (see Fig. 3 supra). The other claims before us are also dependent claims, which further limit the values of the expansion ratios, specify the article's dimensions, describe the material from which the article is made, specify the number of open and closed ends in the article, or set forth further steps for utilizing the end cap.

The Prior Art

United States patent No. 3,526,683 to Heslop et al. ("Heslop") discloses a method of forming a heat recoverable article having different degrees of heat recovery at different parts of the article by a process similar to that taught by appellants. Heslop's articles are particularly useful as sleeves for parts with irregular dimensions such as an insulator for a splice between different size wires, where the article undergoes heat recovery to conform to the shape of the part. In one embodiment of Heslop, a tubular article is cross-linked at an intermediate section thereof, heated, expanded in diameter to the shape shown in Fig. 4 below, and then heat recovered to the shape depicted in Fig. 5 below.

Fig. 4

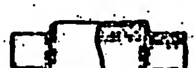

Fig. 5

Heslop's example I indicates that tubular articles, like that of Fig. 4, can have open end sections with expansion ratios of 3.33, and an intermediate section with an expansion ratio of 1.9.

United States patent No. 3,847,183 to Meyer discloses heat recoverable closures for protecting cables from moisture penetration. The ends of the cables are protected by end caps having an open end and a closed end, while cables spliced together are encased in a cylindrical sleeve having two open ends.

United States patent No. 3,992,570 to Beinhaur discloses a rubber end cap which is placed over the end of a cable by axially aligning the closed end of the cap and the end of the cable and forcing the remainder of the cap over the closed end and over the exterior of the cable so that the cap is turned inside out.

Board Opinion

The board affirmed the examiner's rejection of claims 35-40 and 42-67[4] under 35 U.S.C. §103 stating:

> [I]t is evident from Heslop that hollow heat-shrinkable articles having variant sections of independent and different heat-shrinkability are known so that they may be used as a sleeve to encapsulate various irregularly shaped forms. The fact that in the specific embodiments of Heslop the expansion ratios of the open and intermediate sections are in reverse order than [sic, from] those claimed is not seen to distract from its value as a reference to suggest the instantly claimed invention. It clearly would be apparent to the average routineer in this field that either the end or intermediate sections could be made to have a greater or smaller expansion ratio, respectively, depending on a particular application to which the article is to be put.

As to appellants' argument that their articles do not split, the board concluded:

> Only the obvious result is achieved by appellant [sic, appellants] by selecting an expansion ratio of the open end to be smaller than the expansion ratio of the intermediate section.
>
> * * * *
>
> * * * Although the reason for appellants' modification finds no response in the art, nevertheless, the art is suggestive of the claimed variations and, accordingly, no patentable distinctiveness can lie on this basis * * * *

The board also concluded that the teachings of Meyer and Beinhaur would have been

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[3] Claim 52 depends directly from claim 49 which provides an antecedent basis for "the closed end section."

[4] Appellants do not appeal the board's decision sustaining the examiner's rejection of claims 35-40, 54, and 65-67.

properly combinable with those of Heslop to provide Heslop's article with a closed end section and to telescopically insert a cable sealing device, respectively.

Analysis

[1,2] At the outset, we caution the Solicitor that obviousness is a question of law to be determined from the facts. Stratoflex, Inc. v. Aeroquip Corp., 713 F.2d 1530, 1535, 218 USPQ 871, 876 (Fed. Cir. 1983); Stevenson v. International Trade Commission, 612 F.2d 546, 549, 204 USPQ 276, 279 (CCPA 1979); In re May, 574 F.2d 1082, 1089, 197 USPQ 601, 606–07 (CCPA 1978). A conclusion of obviousness is not reviewed under the clearly erroneous standard, which is applicable to fact findings. See Raytheon Co. v. Roper Corp., 724 F.2d 951, 220 USPQ 592 (Fed. Cir. 1983). Rather, such a conclusion is reviewed for correctness or error as a matter of law. In re Carleton, 599 F.2d 1021, 1024 n.14, 202 USPQ 165, 169 n.14 (CCPA 1979).

1. Prima Facie Obviousness

With respect to claims 42–48, we agree with the board that it would have been prima facie obvious to reverse the order of the expansion ratios in Heslop's article so that it would have an hour glass shape after heat recovery. Although the heat shrinkable article in Figs. 4 and 5 of Heslop has an arrangement of expansion ratios opposite to that of appellants' article, Heslop teaches the broad concept of producing heat shrinkable articles with portions having different expansion ratios so that the articles conform to parts with irregular dimensions after heat recovery. When a portion of the part to be covered has a smaller diameter than that of its surrounding portions, which are also to be covered, we are satisfied that it would have been prima facie obvious to one of ordinary skill in the art, from the teachings of Heslop, to utilize a heat shrinkable article with expansion ratios permitting its recovery to an hour glass shape.

We also agree with the board that it would have been prima facie obvious to close one end of Heslop's heat shrinkable articles to form an end cap, as specified by claims 49–51 and 53. It is well known to mak heat shrinkable articles in the shape of end caps rather than tubes when sealing the end of a single wire rather than two spliced wires, as taught by Meyer. H wever, as admitted by the Solicitor at ral argument, the combination of Heslop and Meyer fails to suggest providing a gripping protuberance on the outside of the closed end, and, therefore, the board's decision with respect to claim 52 is erroneous as a matter of law.

We agree with appellants that the references would have failed to suggest to one of ordinary skill in the art the steps of: heating to form a collar at the open end section which flares out of contact with the part being covered (claim 55) and heating the open end section of an end cap to cause shrinkage of the open end section without shrinking the remainder of the cap (claim 59). Accordingly, the board's approval of the rejection of these independent claims, along with their dependent claims 56–58 and 60–64, respectively, is erroneous as a matter of law.[5]

2. Unexpected Results

Appellants argue that, even if the PTO established a prima facie case of obviousness, it has been rebutted, because the claimed invention unexpectedly overcomes the splitting problem discussed supra. Also, they point out that the prior art of record does not suggest avoiding the splitting problem by utilizing appellants' technique.

In response to appellants' assertions of unexpected results, the Solicitor states in his brief: "There is no *objective evidence* in the record that 'no splitting' is, in fact, a result of their claimed invention, much less than it is unexpected."

In their reply brief, appellants argue that their assertions of unexpected results *are* supported by objective evidence. Specifically, appellants rely on the following passages in their specification:

> On the other hand, in order fully to utilize the advantages of the present invention, the second region generally exhibits a high degree of available recovery. The expansion ratios which will, in the absence of end sections as required by the present invention[,] lead to splitting on shrinkage are dependent inter alia on the polymer employed and the thickness. There is seldom a problem with expansion ratios be-

[5] In view of our decision to reverse the PTO's rejection of claim 60, we need not decide whether Beinhaur meets the limitations of claim 60. Alth ugh our reversal of the board's affirmance of the rejecti n f claim 59 also makes further consideration f claim 61 unnecessary, we note that claim 61 is also patentable, because, like claim 52, it provides for a gripping protuberance.

low 2.5, and usually expansion ratios of up to 3.0 can safely be used. However, at expansion ratios of 3.5 or higher splitting is usually a problem and this applies more so at ratios of 4.0, 4.5 and 5.0. Thus the present invention is especially applicable at ratios of from 4 to 6 and above, for example up to 10, i.e. where the amount of available recovery is from 400% to 1000%, usually from 400% to 600%, especially when the percentage of unresolved recovery after shrinkage is high.

* * * *

* * * Typical dimensions, in inches, of three such end caps are as follows:

Cap No.	Intermediate Section Diameter After Shrinkage (a)	Cap Diameter Before Shrinkage (b)	End Section Diameter After Shrinkage (d)	End Section Expansion Ratio (1)	Intermediate Section Expansion Ratio (2)
1	0.8	4.0	2.8	1.4	5
2	1.5	6.0	3.5	1.7	4
3	2.5	8.0	4.5	1.8	3.2

(1) b ÷ d; claim 42 range is 1 to 3
(2) a ÷ d; claim 42 range is greater than 3 [6]

It is appellants' position that the combination of these passages constitutes objective evidence that the splitting problem exists and that the claimed invention overcomes this problem. We disagree.

[3] It is well settled that unexpected results must be established by factual evidence. Mere argument or conclusory statements in the specification does not suffice. In re Lindner, 457 F.2d 506, 508, 173 USPQ 356, 358 (CCPA 1972). Here, appellants' table of "[t]ypical dimensions" is devoid of any data from which we can determine whether or not the end caps described therein actually split. In essence, appellants ask us to *assume* that the end caps in this table are nonsplitting, because a preceding passage in the specification concludes that no splitting occurs in such articles. Examples requiring such assumptions can hardly be considered factual evidence.

[4] Even if the specification contained objective evidence showing that appellants' heat shrinkable articles do not split, such evidence would not be a satisfactory showing of unexpected results. When an article is said to achieve unexpected (i.e. superior) results, those results must logically be shown as superior *compared* to the results achieved with other articles. In re Swentzel, 219 F.2d 216, 220, 104 USPQ 343, 346 (CCPA 1955). See also In re Palmer, 451 F.2d 1100, 1102, 172 USPQ 126, 128 (CCPA 1971). Moreover, an applicant relying on comparative tests to rebut a prima facie case of obviousness must compare his claimed invention to the closest prior art. In re Merchant, 575 F.2d 865, 869, 197 USPQ 785, 788 (CCPA 1978). Here, appellants have not presented any experimental data showing that prior heat shrinkable articles split. Due to the absence of tests comparing appellants' heat shrinkable articles with those of the closest prior art, we conclude that appellants' assertions of unexpected results constitute mere argument and conclusory statements in the specification which cannot establish patentability. Lindner, supra; In re Wood, 582 F.2d 638, 642, 199 USPQ 137, 140 (CCPA 1978).

[5] Appellants complain, however, that the PTO challenges their assertions of unexpected results for the first time in the Solicitor's brief.[7] They contend that, if we are persuaded by the PTO's position, prosecution should be reopened so that affidavits showing unexpected results can be filed.

[6,7,8,9] It is elementary that the claimed invention must be considered as a *whole* in deciding the question of obviousness. In re Kaslow, 707 F.2d 1366, 217 USPQ 1089 (Fed. Cir. 1983); Stratoflex, 713 F.2d at 1537, 218 USPQ at 877. Although the board and the examiner correctly concluded that the invention of claims 42-51 and 53 would have been prima facie obvious, this conclusion did not properly end consideration of the obviousness question; evidence arising out of secondary considerations must always be considered. Stratoflex, supra; In re Sernaker, 702 F.2d

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[6] The table in the specification differs from that shown above in that the latter sets forth expansion ratios and contains some explanatory information not included in the former, while the former includes additional dimensions not set forth in the latter.

[7] It is true that the Solicitor cannot raise a new ground of rejection or apply a new rationale to support a rejection in appeals from decisions of the board. In re Strahilevitz, 668 F.2d 1229, 212 USPQ 561 (CCPA 1982). However, we cannot ignore the substance of the Solicitor's arguments and reverse the board in the face of a prima facie case of obviousness unrebutted by objective evidence. At the same time, an affirmance is not appropriate in view of the PTO's conduct, discussed infra.

989, 996, 217 USPQ 1, 7 (Fed. Cir. 1983).[8] Despite appellants' arguments throughout prosecution that heat shrinkable articles with the claimed expansion ratios overcome the longstanding splitting problem, the board and the examiner merely concluded that these ratios would have been obvious without properly responding to appellants' allegations of unexpected results. Although appellants failed to make an adequate showing of unexpected results, if the board or the examiner had considered this point when the case was pending before them and had pointed out that there was no objective evidence of unexpected results, appellants would, at least, have had notice and would have had an opportunity to file objective evidence.[9] Neither the board nor the examiner, however, gave such notice, and, therefore, appellants were led to believe, albeit erroneously, that they had satisfied their burden of going forward with objective evidence to rebut the prima facie case of obviousness. In re Rinehart, 531 F.2d 1048, 189 USPQ 143 (CCPA 1976). In view of the PTO's failure to challenge the sufficiency of appellants' rebuttal evidence until this appeal, when appellants could no longer offer evidence, we conclude that it is necessary to vacate the board's decision on claims 42-51 and 53 and to remand the case to afford appellants the opportunity to submit objective evidence of unexpected results. See In re Wiechert, 370 F.2d 927, 933, 152 USPQ 247, 251-52 (CCPA 1967).

[8] A proper showing of unexpected results will rebut a prima facie case of obviousness. In re Fenn, 639 F.2d 762, 208 USPQ 470 (CCPA 1981); In re Murch, 464 F.2d 1051, 175 USPQ 89 (CCPA 1972).

[9] Examiners will consider an affidavit or declaration under 37 C.F.R. §1.132 if submitted prior to final rejection or with the first response after final rejection for the purpose of overcoming a new ground of rejection or requirement made in the final rejection. United States Patent and Trademark Office, Manual of Patent Examining Procedure §716 (4th ed. rev. 1982). Affidavits or declarations filed after final rejection will be considered if a satisfactory showing under 37 C.F.R. §1.116(b) or 37 C.F.R. §1.195 is made. Id. Where the board makes a decision advancing a position or rationale new to the proceedings, an applicant must be afforded an opportunity to respond to that position or rationale by submission f contradicting evidence. In re Eynde, 480 F.2d 1364, 178 USPQ 470 (CCPA 1973). Accordingly, if the board or the examiner in this case had stated that there was no objective evidence, appellants would have been entitled to respond by filing such evidence.

Summary

The decision of the board is *reversed* with respect to claims 52 and 55-64 and *vacated* with respect to claims 42-51 and 53. The case is *remanded* f r further proceedings consistent with this opinion.

Reversed-in-Part; Vacated-in-Part; and Remanded

Court of Appeals, Fifth Circuit

Falcon Rice Mill, Inc. v. Community Rice Mill, Inc. et al

No. 82-4451

Decided Feb. 21, 1984

UNFAIR COMPETITION

1. Appearance of goods or labels — In general (§68.201)

"Trade dress" is concept that embraces total image of given product, including advertising materials and marketing techniques used to promote sale.

TRADEMARKS

2. Marks and names subject to ownership — Descriptive — Particular marks (§67.5081)

"Toro" is generic term with respect to rice and may not properly be subject of Louisiana trademark protection.

3. Jurisdiction of courts — Joinder of causes of action and parties — Trademarks and unfair competition (§43.357)

Lanham Act prohibits infringement within single state, of trademark used in interstate commerce; Section 43 provides that Act applies whenever goods violating its provisions "enter into commerce;" Section 45 provides that "commerce" means all commerce that can be regulated by Congress; Act would extend to alleged infringer's intrastate activities that had impact on plaintiff's interstate activities.